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COTTON-TILLAGE STUDIES ON RED BAY SANDY LOAM

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INTRODUCTION

Tillage equipment and methods in the Cotton Belt vary widely. Some methods have been adopted without consideration of the efficient use of land, labor, power, or machinery. In the last 20 years many improvements have been made in tractors and tillage tools, but such equipment has come into use slowly in the Southeastern States. There are three principal reasons for this: (1) Sufficient hand labor must be available on cotton farms for chopping and picking, operations for which satisfactory machinery is not yet available; (2) existing equipment is not adapted to many of the conditions in the Southeast; and (3) there is a lack of specific information on the benefits of tillage practices. Cotton growers have often been led to believe that a finely pulverized seedbed produced by many tillage operations will give maximum yields and that a good rule to follow for cultivation is "a furrow per row per week." That such practices are not always best is shown in this circular by the results of experiments on Red Bay sandy loam.

The relationships between soil manipulation, the physical changes produced in or on the soil, weed control, and yield have not heretofore been studied to any great extent, yet profits from cotton production are dependent in part on the selection of equipment and the character of the tillage operations.

The study of cotton-production machinery begun in 1931 was carried on cooperatively by the Bureau of Agricultural Engineering and the Alabama and Mississippi Agricultural Experiment Stations.[1] This research work was recommended and approved by the advisory council in mechanical farm equipment (*10*)[2] in 1928. The object of the work was to find out what physical conditions of the soil are most favorable for producing maximum yields of cotton, and to select the tillage equipment and methods best suited to producing these conditions. Plots were laid out to study the effects of depth, type, number, and time of operations in preparation of seedbeds and the effects of

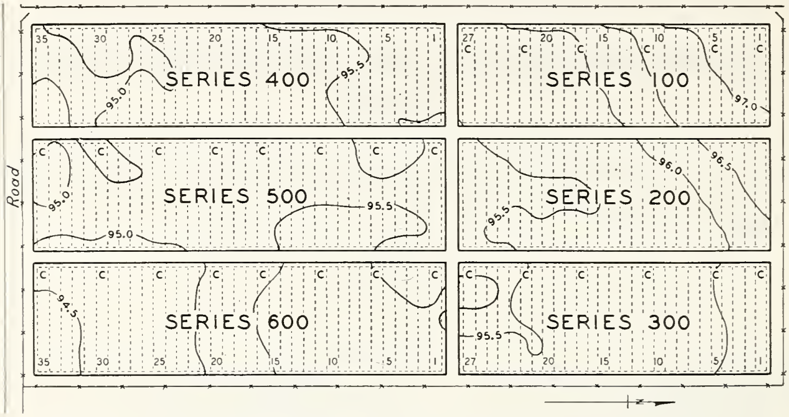

FIGURE 1.—Lay-out of test plots showing location of check plots, (C).

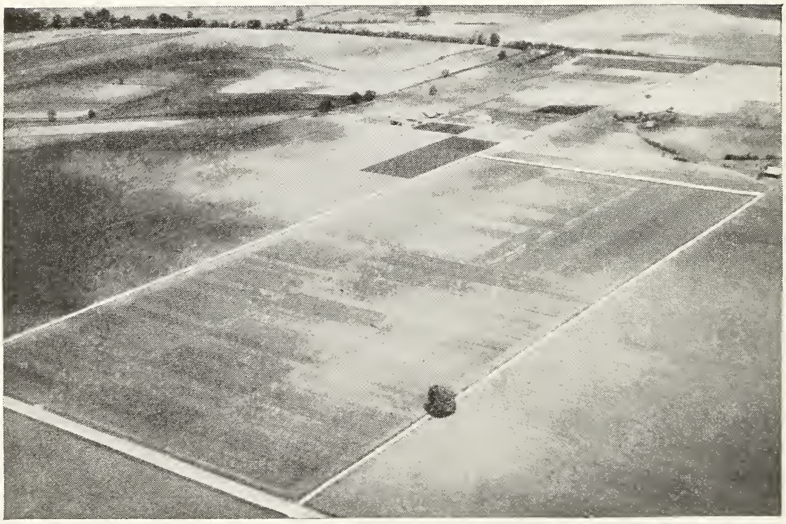

FIGURE 2.—Aerial view of the Prattville field in the spring of 1935 following a rain and after all seedbeds were ready for planting. Photo by Fourth Photo Section, Air Corps, Maxwell Field, Montgomery, Ala.

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[1] The authors gratefully acknowledge assistance of M. L. Nichols and J. T. Williamson, Alabama Agricultural Experiment Station, in planning the experiments.

[2] Italic numbers in parentheses refer to Literature Cited p. 54.

frequency, depth and type of cultivation (figs. 1 and 2). This circular gives the results of 6 years of investigation (1932–37) on Red Bay sandy loam near Prattville, Ala.

The data and results shown herein are directly applicable only to this soil and the types of seasons indicated. The soils of several million acres of the Coastal Plains have properties similar to Red Bay sandy loam though classified under other names. The findings set forth herein doubtless apply to some extent to most soils coming under the old classification of the Greenville series.

The Mississippi Agricultural Experiment Station has recently published a compilation of experimental data relating to the planting and cultivation of cotton carried on in several States. (*7*)

PRATTVILLE FIELD SOIL AND ITS REACTION TO TILLAGE IMPLEMENTS

Red Bay sandy loam is a highly weathered terrace soil. It consists of chocolate-colored sandy loam to a depth of 4 to 5 inches with a red and mottled clay subsoil.

Mechanical analyses of surface-soil samples taken at close intervals over the entire field show that the soil is uniform. The average mechanical analysis of the surface soil shows the following constituents in percent: Fine gravel, 1.56; coarse sand, 13.44; medium sand, 21.36; fine sand, 21.42; very fine sand, 5.47; silt, 16.42; clay (including colloid) 20.33.

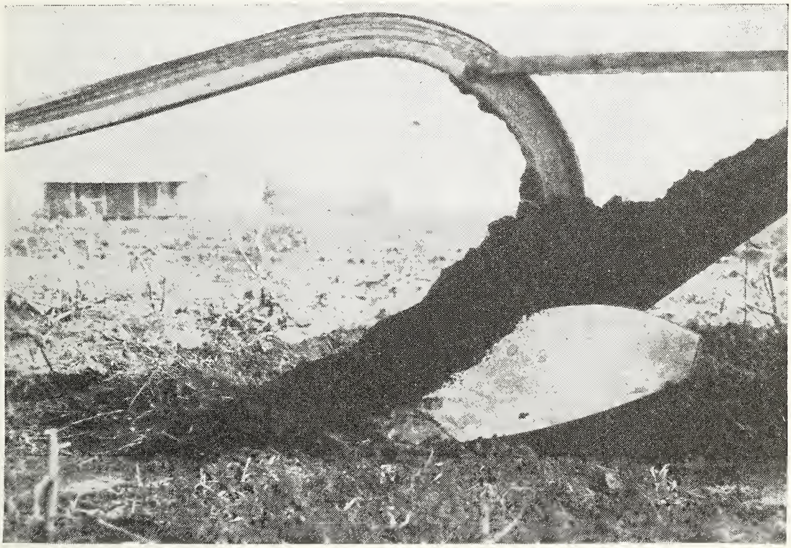

FIGURE 3.—The middle breaker pushed rather than turned the soil, thus increasing the draft.

The soil is sometimes termed "push soil," since the soil particles when moist stick to the surface of a tillage tool more readily than to each other. (Fig. 3.) Thus the soil is pushed to one side with soil slipping over soil instead of sliding smoothly over the metal surface.

This is caused by the character of the subsoil as the top 3 to 4 inches of soil scours readily. When the soil is dry and hard, deep tillage tends to break it into large clods or lumps. With increasing moisture, the soil tends to pulverize more as it passes over the moldboard until the moisture content is near that of the lower plastic limit, i. e. the lowest moisture content at which a soil can just be rolled into a wire one-eighth of an inch in diameter without breaking into lengths shorter than three-eighths of an inch. The soil sticks to the moldboards of plows and middle breakers [3] when the moisture content is above this point.

EXPERIMENTAL PROCEDURE

The Prattville experimental field contained 20 acres. The plots were all one-twelfth of an acre in size. One plot in each group of five was used as a check to enable correction of the yields of plots for soil variation. All plots were duplicated (figs. 1 and 2). The plots were grouped into the following series:

Series 100, row cultivation.
Series 200, cotton planting.
Series 300, cross-row cultivation.
Series 400, seedbed preparation in the spring.
Series 500, seedbed preparation at different seasons (deep).
Series 600, seedbed preparation at different seasons (shallow).

All studies to determine the effects and value of methods of row cultivation were confined to series 100. These studies included keeping the weeds out by hoeing only, by different numbers of shallow cultivations, by deep cultivation at different periods, and by disk cultivation. Series 200 was used for cotton-planting-methods studies.

The rows on series 300 were run crosswise of the plots so that cultivations lengthwise of the plots were across the rows. The rows, however, were continuous across the series of plots so that uniform row cultivation could be given all plots after the cross-row cultivations with harrows, rotary hoes, etc., were completed.

Series 400, 500, and 600 were used for studies of methods of seedbed preparation. Not all methods used by farmers in the Southeast could be tried, but representative methods were chosen and a few unusual methods were included for comparison. The methods used varied from no seedbed preparation other than breaking up the old stalks to the use of a large number of machine operations requiring much power and labor. The methods used on series 400 consisted of those practiced in the upland and hill areas, all work was done in the spring and to depths not exceeding 4 inches, and small one- and two-mule outfits were used for nearly all operations. The seedbeds in series 600 were prepared shallow also, but not all work was done in the spring. Series 500 duplicated series 600 but the soil was worked approximately twice as deep as on series 600.

The general procedure used for these studies, described more fully by Randolph (*9*), was to compare a plot prepared by a single machine operation with plots on which a number of operations were performed in succession. By keeping all other tillage operations the same, a comparison of these plots would give the values of various operations.

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[3] A middle breaker is the equivalent of two small right- and left-hand plows welded together. The middle breaker is used to throw dirt both ways from a row in the row-breaking operation. In breaking the middles this tillage tool is used to throw dirt to row. The moldboard plow can accomplish the same effects in tearing down or building a seedbed but will require extra operations.

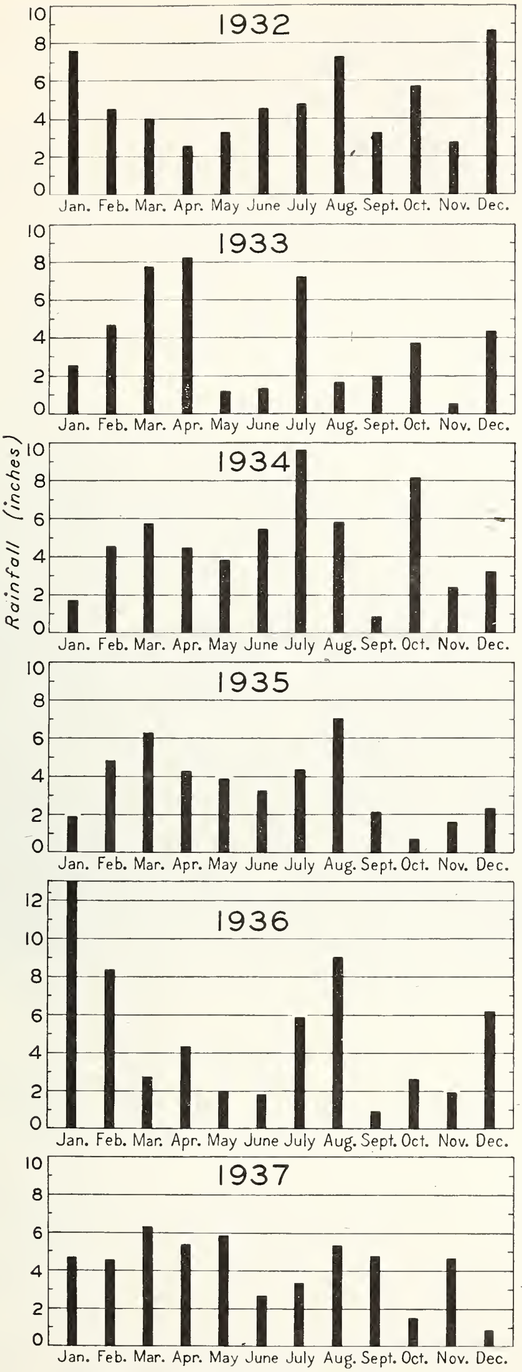

FIGURE 4.—Monthly rainfall, 1932–37.

An effort was made to work the soil under average moisture conditions. For the fall work the soil had a low amount of moisture, during the winter work the soil was slightly moist, and for the spring work the soil varied from a moist to a medium dry condition.

The rainfall for the 6 years covered is shown in figure 4. Where reliable rainfall records at the Prattville field were available these were used in plotting the charts, otherwise records of the Weather Bureau at Prattville, 3 miles distant, were used.

FACTORS CONSTANT FOR ALL PLOTS

So far as possible, such factors as seed, fertilizer, and freedom from weeds, except as noted, were kept constant for all plots. An approved strain of the upland medium-staple Cook cotton was planted each year. All seed was delinted for the years 1933 and 1934. Other years recleaned, gin-run seed was used.

The Bureau's variable-depth method of planting cotton, described later (p. 30), was used on all plots except those on which planting methods were tested. All plots were fertilized at the rate of 600 pounds per acre with 6–8–4 (nitrogen, phosphoric acid, potassium) commercial fertilizer. The fertilizer was placed in a band 2 to 3 inches to the side of the row and 3 inches below the soil surface as this location was found in tests by Cumings (*4*) to be near optimum. The fertilizer was delivered to the row mechanically by a top-delivery-type fertilizer hopper at planting time the first 2 years. Mehring and Cumings (*6*) have shown this distributor to be very accurate. In 1934, 1935, 1936, and 1937 cultivator shovels or disks were set to run near the young cotton and throw the soil away from the row at the first cultivation, leaving the cotton on a narrow ridge or balk. The exact amount of fertilizer intended for each row was weighed out and applied in one of the furrows by hand.

Boll weevil infestation was very slight except in 1934 and 1935, when dust applications, based on recommendations of the Alabama Agricultural Experiment Station, were made uniformly on all plots and were effective in preventing appreciable damage.

Weeds were not allowed to grow on any of the plots up to July 15, except on certain of the plots in the cultivation series. If the method outlined for the plot failed to kill the weeds they were removed by hoe labor and the extra labor charged to that method.

TILLAGE IMPLEMENTS USED

The following tillage implements, found by preliminary studies in 1932 to be the most suitable for this locality, were used in the experiment:

Operation	Equipment
Plowing	14-inch slat moldboard plow of the stubble-bottom shape. Share and mold of soft-center steel, having the cutting edge coated with hard metal.
Bedding by plowing 2 furrows on row from each side.	9-inch, soft-center steel, blackland-type plow with a slow inversion moldboard.
Breaking row or middle	10-inch soft-center steel burster or breaker with gradual-turn molds.
Disking	4-foot, orchard-type, disk harrow with 18-inch disks spaced 6 inches.

Operation	Equipment
Disk bedding	4-foot, orchard-type, disk harrow as above with disks reversed and tilted for throwing up beds between gangs.
Harrowing	Rigid-frame, adjustable-angle spike-tooth harrow or single-point spring-tooth harrow.
Chiseling	3-inch, straight shovel on plow stock.
Smoothing	Wood float, saw-tooth assembly of four 2- by 12-inch planks or spike-tooth harrow.
Row cultivation by methods explained in text.	Shallow: Thin sweeps of several sizes on tractor cultivator. Disk gangs on 1-row cultivator. Deep: 5-inch, diamond-point shovels on 1-row cultivator.
Cross-row cultivation	Weeder, 7-foot, spring-tooth. Rotary hoe, 7-foot. Spike-tooth harrow, 2 sections.

DRAFT STUDIES

A hydraulic-type recording dynamometer mounted in a special cart was used for making most of the measurements of the draft requirements of the tillage operations. The cart was arranged with adjustments so that the dynamometer could be hitched between a power source and an implement without disturbing the normal hitch relationship (fig. 5). Special dynamometers and dynamometer mountings were used whenever the cart could not be hitched satisfactorily.

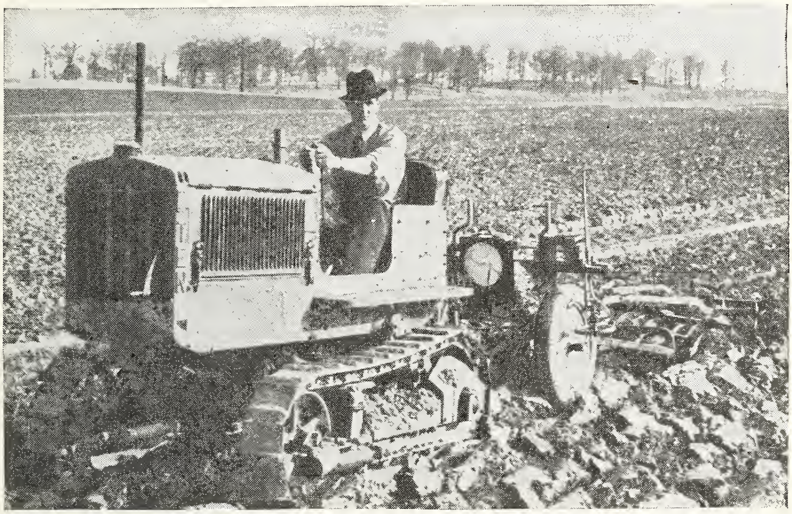

FIGURE 5.—Hydraulic dynamometer mounted in cart as used for measuring the draft of plows and other tillage equipment.

Enough draft tests were made on each implement under various conditions to determine a fair average value of the energy required. These average values were converted to the equivalent draft per 40-inch width of row to give them a uniform base. The draft data indicate that the power requirements for any operation or group of operations will vary with changes in the soil conditions at the time the work is done. The draft data for seedbed preparation shown in tables 1, 2, and 3 and figures 6 and 7 are the averages of all data obtained on the plots.

The draft of the cultivator with given equipment varied with the character of the seedbed preparation for the first cultivation, but there was no significant difference in the draft of a conventional one-row riding cultivator for succeeding cultivations.

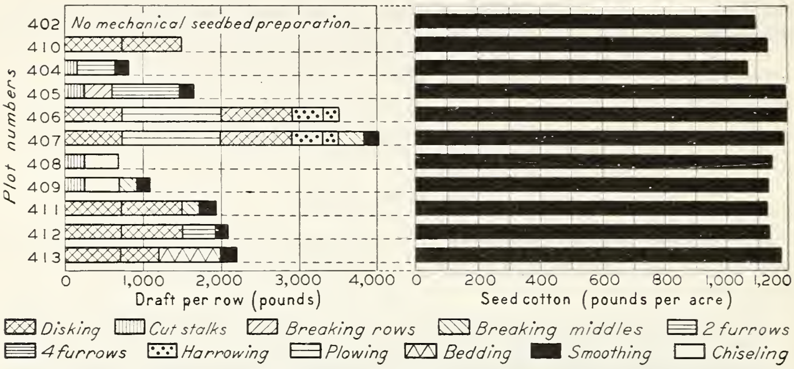

FIGURE 6.—Operations, drafts, and yields for the seedbed preparation used on series 400. Data for plots 408, 409, and 413 are averages of 3 years; all others are averages of 5 years.

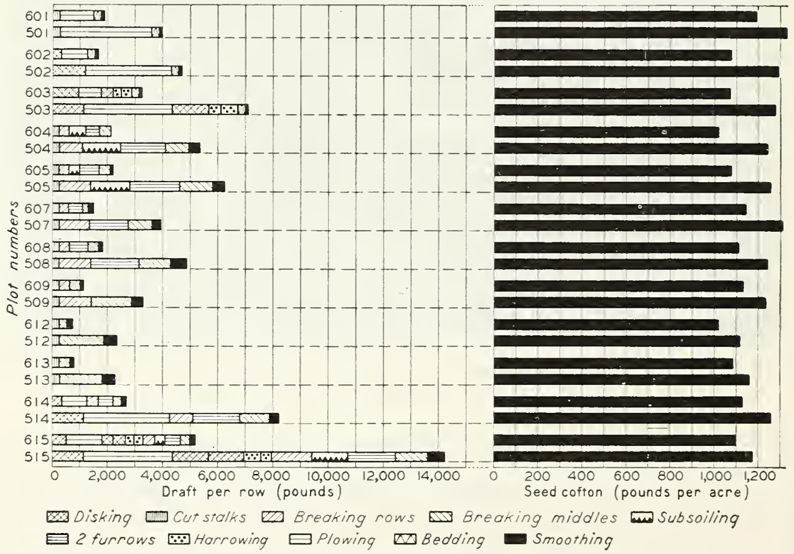

FIGURE 7.—Operations, drafts, and yields for the seedbed-preparation methods used on series 500 and 600. Data for plots 513, 514, 515, 603, 605, 613, 614, and 615 are averages of 4 years; all others are averages of 5 years.

TABLE 1.—*Operation, power, and labor used, and yield on shallow-seedbed-preparation plots worked in the spring, series 400*

[Planted approximately April 16]

Plot No.	Approximate date of machine operation	Operation	Equivalent draft per 40-inch row	Calculated horsepower hours per acre	Mule work per acre	Man labor per acre using 2-mule equipment	Extra hand labor per acre— Before planting	Extra hand labor per acre— After planting [1]	Average weighted yield of seed cotton per acre
			Pounds	*Number*	*Hours*	*Hours*	*Hours*	*Hours*	*Pounds*
401		Hand pulling of stalks and hoe work		0.0			74.9	47.2	959
402		do		.0			43.5	18.6	1,100
404		Cutting stalks and hand pulling roots	250		2.4	1.2	18.6		
	Mar. 20	Plowing two 9-inch furrows on row	400		4.6	2.3			
	Apr. 15	Smoothing	170		2.0	1.0			
		Total	820	5.4	9.0	4.5	18.6	19.0	1,075
405		Cutting stalks	250		2.4	1.2			
	Mar. 20	Breaking rows	350		4.2	2.1			
	Mar. 30	Bedding with four furrows	880		10.2	5.1			
	Apr. 15	Smoothing	170		2.0	1.0			
		Total	1,650	10.9	18.8	9.4	.0	18.8	1,199
406	Feb. 1	Double disking	720		6.6	3.3			
	Feb. 15	Plowing	1,320		15.4	7.7			
	Feb. 20	Double disking	920		8.4	4.2			
	Feb. 22	Harrowing (spring tooth)	380		4.4	2.2			
	Feb. 23	Harrowing (peg tooth)	210		2.4	1.2			
		Total	3,550	23.4	37.2	18.6	.0	19.7	1,200
407	Feb. 1	Double disking	720		6.6	3.3			
	Feb. 15	Plowing	1,320		15.4	7.7			
	do	Double disking	920		8.4	4.2			
	do	Harrowing (spring tooth)	380		4.4	2.2			
	Feb. 20	Harrowing (peg tooth)	210		2.4	1.2			
	Mar. 20	Breaking middles	350		4.2	2.1			
	Apr. 15	Smoothing	180		2.0	1.0			
		Total	4,080	26.9	43.4	21.7	.0	18.6	1,192
408		Cutting stalks	250		2.4	1.2			
	Feb. 20	Chiseling with furrows 8 inches apart	440		5.0	2.5			
		Hand pulling old stalks					9.0		
		Total	690	4.6	7.4	3.7	9.0	14.3	[2] 1,153
409		Cutting stalks	250		2.4	1.2			
	Feb. 20	Chiseling with furrows 8 inches apart	440		10.2	5.1			
		Hand pulling old stalks					8.4		
	Mar. 20	Breaking middles	240		2.6	1.3			
	Apr. 15	Smoothing	180		2.0	1.0			
		Total	1,110	7.3	17.2	8.6	8.4	13.7	[2] 1,145
410	Mar. 1	Double disking	720		6.8	3.4			
	Mar. 30	do	800		9.4	4.7			
		Total	1,520	10.0	16.2	8.1	.0	17.8	1,138
411	Mar. 1	Double disking	720		6.6	3.3			
	Mar. 20	do	800		9.4	4.7			
	Mar. 25	Breaking middles	210		2.4	1.2			
	Apr. 15	Smoothing	200		2.4	1.2			
		Total	1,930	12.7	20.8	10.4	.0	18.3	1,141
412	Mar. 1	Double disking	720		6.6	3.3			
	Mar. 20	do	800		9.4	4.7			
	Mar. 25	Plowing two 9-inch furrows on row	440		4.8	2.4			
	Apr. 15	Smoothing	180		2.0	1.0			
		Total	2,140	14.1	22.8	11.4	.0	18.2	1,145
413	Mar. 1	Double disking	720		6.6	3.3			
	Mar. 20	Building beds with two trips of reverse-disk gangs	530 800		6.0 9.4	3.0 4.7			
	Apr. 15	Smoothing	200		2.2	1.1			
		Total	2,250	14.8	24.2	12.1	.0	19.7	[2] 1,189

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[1] This column is given here to show the effects of methods of seedbed preparation on this item. The hours required can be compared directly except for plot 401 which received no mechanical cultivations.

[2] 3-year average 1933–35.

TABLE 2.—*Operation, power, and labor used, and yield on shallow-seedbed-preparation plots worked at different seasons, series 600*

[Planted approximately Apr. 16]

Plot No.	Approximate date of machine operation	Operation	Equivalent draft per 40-inch row	Calculated horsepower-hours per acre	Animal power, mules	Mule work per acre	Man labor per acre		Extra hand labor per acre [1]—		Average weighted yield of seed cotton per acre
							2-mule unit	4-mule unit	Before planting	After planting	
			Pounds	*Number*	*Number*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Pounds*
601	December	Cutting stalks	250		2	2.4	1.2	1.2			
	Jan. 17	Plowing	1,230		2 or 4	11.4	5.7	2.9			
	Apr. 3	Bedding (4-disk hillers)	310		2	3.4	1.7	1.7			
	Apr. 15	Smoothing	120		2 or 4	1.4	.7	.4			
		Total	1,910	12.6		18.6	9.3	6.2	0.0	19.7	1,195
602	Nov. 13	Single disking	310		2 or 4	3.4	1.7	.9			
	Nov. 20	Plowing	940		2 or 4	8.8	4.4	2.2			
	Apr. 1	Bedding (4-disk hillers)	310		2	3.4	1.7	1.7			
	Apr. 15	Smoothing	120		2 or 4	1.4	.7	.4			
		Total	1,680	11.1		17.0	8.5	5.2	.0	17.9	1,095
603	Mar. 15	Single disking	470		2 or 4	4.4	2.2	1.2			
	Mar. 26	Plowing	1,300		2 or 4	12.2	6.1	3.1			
	Apr. 4	Single disking	410		2 or 4	4.6	2.3	1.2			
	Apr. 5	Drag harrowing	320		2 or 4	3.8	1.9	.9			
	Apr. 6	Spring-tooth harrowing	340		2 or 4	4.0	2.0	1.0			
	do	Bedding (4-disk hillers)	270		2	3.4	1.7	1.7			
	Apr. 15	Smoothing	120		2 or 4	1.4	.7	.4			
		Total	3,230	21.3		33.8	16.9	9.5	.0	17.9	[2] 1,072
604	Nov. 20	Cuting stalks	250		2	2.4	1.2	1.2			
	do	Breaking out old rows	330		2 or 4	3.8	1.9	1.0			
	Dec. 10	Subsoiling with 3-inch shovel	420		2 or 4	3.8	1.9	1.0			
	Mar. 11	Listing back 2 plow furrows	540		2	5.6	2.8	2.8			
	Mar. 22	Breaking out old middles	290		2 or 4	3.4	1.7	.8			
	Apr. 15	Smoothing	140		2 or 4	1.6	.8	.4			
		Total	1,970	13.0		20.6	10.3	7.2	.0	19.1	1,038

605	February	Cutting stalks	250		2	2.4	1.2	1.2			
	Mar. 17	Breaking out old rows	350		2 or 4	3.4	1.7	.8			
	Mar. 19	Subsoiling with 3-inch furrows	400		2 or 4	3.8	1.9	.9			
	Mar. 31	Listing back 2 plow furrows	680		2	6.4	3.2	3.2			
	Apr. 15	Breaking out old middles	400		2 or 4	4.6	2.3	1.2			
	do	Smoothing	120		2 or 4	1.4	.7	.4			
		Total	2,200	14.5		22.0	11.0	7.7	.0	19.0	[2] 1,047
607	December	Cutting stalks	250		2	2.4	1.2	1.2			
	Jan. 23	Breaking out old rows	320		2 or 4	3.0	1.5	.8			
	Feb. 6	Listing back 2 plow furrows	480		2	4.6	2.3	2.3			
	Feb. 9	Breaking middles	210		2 or 4	2.4	1.2	.6			
	Apr. 15	Smoothing	210		2 or 4	2.4	1.2	.6			
		Total	1,470	9.7		14.8	7.4	5.5	.0	20.9	1,133
608	Fall	Cutting stalks	250		2	2.4	1.2	1.2			
	Mar. 13	Breaking out old rows	350		2 or 4	3.4	1.7	.9			
	Mar. 20	Listing back 2 plow furrows	660		2 or 4	7.6	3.8	3.8			
	Apr. 1	Breaking middles	380		2 or 4	4.4	2.2	1.1			
	Apr. 15	Smoothing	170		2 or 4	2.0	1.0	.5			
		Total	1,810	11.9		19.8	9.9	7.5	.0	19.5	1,092
609	Fall	Cutting stalks	250		2	2.4	1.2	1.2			
	Mar. 8	Breaking rows	360		2 or 4	3.2	1.6	.8			
	Mar. 25	Breaking middles	380		2 or 4	4.4	2.2	1.1			
	Apr. 15	Smoothing	160		2 or 4	1.9	1.0	.5			
		Total	1,150	7.6		11.9	6.0	3.6	.0	20.5	1,125
612	Fall	Cutting stalks	250		2	2.4	1.2	1.2			
	Jan. 1	Breaking middles	320		2 or 4	2.8	1.4	.7			
	January	Pulling stalks							12.0		
	Apr. 15	Smoothing	160		2 or 4	1.9	1.0	.5			
		Total	730	4.9		7.1	3.6	2.4	12.0	21.2	1,044
613	Fall	Cutting stalks	250		2	2.4	1.2	1.2			
	March	Pulling old stalks							10.1		
	Mar. 29	Breaking middles	400		2 or 4	3.8	1.9	1.0			
	Apr. 15	Smoothing	150		2 or 4	1.7	.9	.4			
		Total	800	5.3		7.9	4.0	2.6	10.1	20.3	1,096

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[1] This column is given here to enable comparing the effects of the several methods of seedbed preparation on this item.

[2] 5-year average, 1932–36.

TABLE 2.—*Operation, power, and labor used, and yield on shallow-seedbed-preparation plots worked at different seasons, series 600*—Continued

[Planted approximately Apr. 16]

Plot No.	Approximate date of machine operation	Operation	Equivalent draft per 40-inch row	Calculated horsepower-hours per acre	Animal power, mules	Mule work per acre	Man labor per acre		Extra hand labor per acre—		Average weighted yield of seed cotton per acre
							2-mule unit	4-mule unit	Before planting	After planting	
			Pounds	*Number*	*Number*	*Hours*	*Hours*	*Hours*	*Hours*	*Hours*	*Pounds*
614	Nov. 11	Single disking	320		2 or 4	3.0	1.5	0.8			
	Nov. 13	Plowing	1,060		2 or 4	10.0	5.0	2.5			
	Dec. 26	Breaking rows	390		2 or 4	3.8	1.9	.9			
	Mar. 14	Listing back 2 plow furrows	540		2	5.0	2.5	2.5			
	Mar. 25	Breaking middles	310		2 or 4	2.8	1.4	.7			
	Apr. 15	Smoothing	200		2 or 4	2.4	1.2	.6			
		Total	2,820	18.6		27.0	13.5	8.0	0.0	19.3	1,144
615	Mar. 14	Single disking	470		2 or 4	4.4	2.2	1.1			
	Mar. 16	Plowing	1,270		2 or 4	14.0	7.0	3.5			
	do	Single disking	410		2 or 4	4.8	2.4	1.2			
	Mar. 30	do	420		2 or 4	4.8	2.4	1.2			
	Apr. 2	Spring-tooth harrowing	320		2 or 4	3.8	1.9	1.0			
	do	Drag harrowing	320		2 or 4	3.8	1.9	.9			
	Apr. 5	Breaking out old rows	330		2 or 4	3.8	1.9	1.0			
	Apr. 6	Subsoiling in breaker furrows	440		2 or 4	5.0	2.5	1.2			
	Apr. 7	Listing back 2 plow furrows	580		2	6.6	3.3	3.3			
	do	Breaking middles	340		2 or 4	4.0	2.0	1.8			
	Apr. 15	Smoothing	250		2 or 4	3.2	1.6	.8			
		Total	5,150	34.0	----	58.2	29.1	17.0	.0	19.8	1,111

TABLE 3.—*Operation, power, and labor used, and yield on deep-seedbed-preparation plots worked at different seasons, series 500*

[Planted approximately Apr. 16]

Plot No.	Approximate date of machine operation	Operation	Equivalent draft per 40-inch row	Calculated horsepower-hours per acre	Animal power-mules	Mule work per acre	Man labor per acre	Extra hand labor per acre[1]—		Average weighted yield of seed cotton per acre
								Before planting	After planting	
			Pounds	*Number*	*Number*	*Hours*	*Hours*	*Hours*	*Hours*	*Pounds*
501	December	Cutting stalks	250		2	2.4	1.2			
	Jan. 15	Plowing	3,340		4	32.0	8.0			
	Apr. 3	Bedding (4-disk hillers)	280		2	3.0	1.5			
	Apr. 15	Smoothing	120		4	1.4	.4			
		Total	3,990	26.3		38.8	11.1	0.0	20.8	1,324
502	Nov. 13	Double disking	1,180		4	12.0	3.0			
	Nov. 20	Plowing	3,090		4	29.6	7.4			
	Apr. 3	Bedding (4-disk hillers)	290		2	3.0	1.5			
	Apr. 15	Smoothing	120		4	1.4	.4			
		Total	4,680	30.9		46.0	12.3	.0	20.1	1,295
503	Mar. 11	Double disking	1,140		4	10.4	2.6			
	Mar. 19	Plowing	3,220		4	33.6	8.4			
	Mar. 26	Double disking	1,280		4	15.2	3.8			
	Mar. 30	Drag harrowing	410		4	4.8	1.2			
	Apr. 2	Spring-tooth harrowing	620		4	7.2	1.8			
	Apr. 6	Bedding (4-disk hillers)	290		2	3.0	1.5			
	Apr. 15	Smoothing	120		4	1.4	.4			
		Total	7,080	46.7		75.6	19.7	.0	19.5	1,283
504	Nov. 15	Cutting stalks	250		2	2.4	1.2			
	Nov. 20	Breaking out old rows	810		4	8.0	2.0			
	Dec. 10	Subsoiling with 3-inch shovels	1,380		4	13.2	3.3			
	Mar. 8	Listing back 2 plow furrows	1,650		4	16.8	4.2			
	Mar. 10	Breaking out old middles	850		4	10.0	2.5			
	Apr. 15	Smoothing	390		4	4.6	1.2			
		Total	5,330	35.2		55.0	14.4	.0	20.3	1,238

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[1] This column is given here to enable comparing the effects of the several methods of seedbed preparation on this item.

TABLE 3.—*Operation, power, and labor used, and yield on deep-seedbed-preparation plots worked at different seasons, series 500*—Continued

Plot No.	Approximate date of machine operation	Operation	Equivalent draft per 40-inch row	Calculated horsepower-hours per acre	Animal power-mules	Mule work per acre	Man labor per acre	Extra hand labor per acre—		Average weighted yield of seed cotton per acre
								Before planting	After planting	
			Pounds	*Number*	*Number*	*Hours*	*Hours*	*Hours*	*Hours*	*Pounds*
505	February	Cutting stalks	250		2	2.4	1.2			
	Mar. 3	Breaking out old rows	1,150		4	12.0	3.0			
	Mar. 12	Subsoiling with 3-inch furrows	1,380		4	16.0	4.0			
	Mar. 25	Listing back 2 plow furrows	1,840		4	21.6	5.4			
	Mar. 30	Breaking out old middles	1,160		4	13.6	3.4			
	Apr. 15	Smoothing	470		4	5.6	1.4			
		Total	6,250	41.3		71.2	18.4	0.0	20.5	1,253
507	December	Cutting stalks	250		2	2.4	1.2			
	Jan. 23	Breaking out old rows	1,090		4	10.4	2.6			
	Feb. 7	Listing back, 2 plow furrows	1,400		4	13.2	3.3			
	Feb. 9	Breaking middles	820		4	8.0	2.0			
	Apr. 15	Smoothing	380		4	4.4	1.1			
		Total	3,940	26.0		38.4	10.2	.0	21.7	1,317
508	Fall	Cutting stalks	250		2	2.4	1.2			
	Mar. 13	Breaking out old rows	1,130		4	12.0	3.0			
	Mar. 30	Listing back 2 plow furrows	1,740		4	20.0	5.0			
	Apr. 6	Breaking middles	1,160		4	13.6	3.4			
	Apr. 15	Smoothing	590		4	7.2	1.8			
		Total	4,870	32.1		55.2	14.4	.0	21.2	1,249
509	Fall	Cutting stalks	250		2	2.4	1.2			
	Mar. 9	Breaking rows	1,110		4	10.8	2.7			
	Mar. 25	Breaking middles	1,480		4	14.8	3.7			
	Apr. 15	Smoothing	460		4	5.2	1.3			
		Total	3,300	21.8		33.2	8.9	.0	20.7	1,254
512	Fall	Cutting stalks	250		2	2.4	1.2			
	Jan. 1	Breaking middles	1,640		4	15.2	3.8			
	January	Pulling stalks			0			10.1		
	Apr. 15	Smoothing	460		4	5.6	1.4			
		Total	2,350	15.5		23.2	6.4	10.1	21.0	1,129

513	Fall	Cutting stalks	250	------	2	2.4	1.2	------	------	------
	Mar. 28	Breaking middles	1,580		4	18.4	4.6	------		
	Mar. 15	Hand pulling old stalks	------		0	------	------	11.5		
	Apr. 15	Smoothing	450		4	5.6	1.4	------		
		Total	2,280	15.0	------	26.4	7.2	11.5	21.3	[2] 1,168
514	Nov. 11	Double disking	1,150	------	4	12.0	3.0	------	------	------
	Nov. 13	Plowing	3,090		4	28.0	7.0			
	Dec. 26	Breaking rows	830		4	8.0	2.0			
	Mar. 14	Listing back 2 plow furrows	1,710		4	16.8	4.2			
	Mar. 24	Breaking middles	1,060		4	12.0	3.0			
	Apr. 15	Smoothing	400		4	4.6	1.2			
		Total	8,240	54.4	------	81.4	20.4	.0	20.5	[2] 1,262
515	Mar. 14	Double disking	1,130	------	4	12.0	3.0	------	------	------
	Mar. 16	Plowing	3,220		4	36.0	9.0			
	do	Double disking	1,280		4	14.8	3.7			
	Mar. 30	do	1,320		4	15.2	3.8			
	Apr. 2	Spring-tooth harrowing	620		4	7.2	1.8			
	do	Drag harrowing	410		4	4.8	1.2			
	Apr. 5	Breaking out rows	1,430		4	16.4	4.1			
	Apr. 6	Subsoiling in breaker furrows	1,300		4	15.2	3.8			
	Apr. 7	Listing back 2 plow furrows	1,740		4	20.1	5.1			
	do	Breaking middles	1,170		4	13.2	3.3			
	Apr. 15	Smoothing	600		------	7.2	1.8			
		Total	14,220	93.8	------	162.1	40.6	.0	20.5	[2] 1,180

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[2] 4-year average, 1932–35.

POWER INDEX

The following procedure was used to obtain a power index for each method of seedbed preparation:

The dynamometer measurements of draft and speed for the various sizes of implements transposed as horsepower-hours per acre, tend to place them and the different types of power units upon a common basis for comparison.

$$\frac{F \times MPH \times 5{,}280}{33{,}000 \times 60} = \text{horsepower} \qquad (1)$$

$$\frac{43{,}560}{W \times MPH \times 5{,}280} = \text{hours per acre} \qquad (2)$$

Where,

F = draft of implement in pounds

W = effective width of implement in feet

Multiplying formula 1 by 2 the factor of speed cancels. Hence,

$$\frac{0.022\ F}{W} = \text{horsepower-hours per acre} \qquad (3)$$

Since machine draft varies with the effective width of the cut of the tool, the draft measurements are expressed as the equivalent draft per row.

$$F \times \frac{\textit{row width}}{W} = F' \qquad (4)$$

When,

F' = equivalent draft per 40-inch row

Row width = 3⅓ feet (40 inches)

$$F \times \frac{3\frac{1}{3}}{W} = F' \quad F = \frac{F'W}{3\frac{1}{3}} \qquad (5)$$

Substituting in (3)

$$\frac{F'W}{3\frac{1}{3}} \times \frac{0.022}{W} = 0.0066\ F' = \begin{array}{c}\text{horsepower-hours per acre}\\ \text{for the operation}\end{array} \qquad (6)$$

The factor of speed within the variations for mule farming has little effect on machine draft as has been shown by Glaves.[4] It has been found, also, that the draft of various-size units varies almost directly with the width of cut so the above method of expressing the power requirements is quite logical, and gives data from which it is possible to determine the draft for any size unit.

Curves were developed from the work capacity of about 40 southern mule units used in these draft studies, and were used as a basis for converting the draft data to man and mule hours per operation per acre. In working up these curves it was found that a mule's capacity for work varied with the season. The limits used in this study for the various conditions were the loads the mules could handle continuously without becoming winded or overheated.

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[4] Ashby, W., Reed, I. F., and Glaves, A. H. Progress report on draft of plows used for corn borer control. 32 p. 1932. Mimeographed.

SEEDBED-PREPARATION EXPERIMENTS

A large number of combinations of methods of seedbed preparation is possible and the dates on which the work is performed can also be varied, thus it is practically impossible to compare all of them. Most of the seedbed-preparation methods used in this study were arrangements of those commonly used in some part of the cotton-producing area. However, this was not the only basis used in selecting the methods. The ultimate purpose of the study was to determine the soil physical conditions most favorable for economical cotton production. Methods having different power and labor requirements (figs. 6 and 7) and employing different types of equipment operated at different depths and at different times of year were used to produce a wide range of soil conditions.

The effects of the various methods on the yield of cotton are shown in tables 1 to 3. Since some farmers plant cotton on bedded land and others on flat land, both methods were used on comparable plots. The land was left flat if plots were finished by plowing, disking, or harrowing with either a spring-tooth or spike-tooth harrow. Beds were formed when the last operation in seedbed preparation was the use of a breaker, a turnplow throwing two or four furrows on the old row, a disk set to throw soil toward the center, a cultivator equipped with disk hillers or twisted shovels, or a combination of these tools.

Although the experimental planter described under Cotton Planting (fig. 18) was heavy enough to cut down the extremely high beds, if the field had been planted with a conventional lightweight one- or two-row planter it would have been necessary to drag down the beds. With high beds this might have been an expensive operation. Two beds were dragged down on each plot in 1936 to obtain the power data for smoothing shown in tables 1 to 3. The use of a heavy planter equipped with a broad sweep would eliminate the greater part of this smoothing as a separate operation, thus saving labor and placing the cotton seed in moist, undisturbed soil. The method of smoothing down the beds that was followed in 1936 tended to compact the soil and break up more of the clods than did the work in previous years.

Tables 1 to 3 give the machine operations for seedbed preparation in chronological order. The average draft requirements for each operation were totaled and converted to horsepower-hours per acre by the methods already explained (p. 16). Average yields were weighted for soil variability based on the 6-year averages of the check plots. Since soil-tillage operations cannot be varied so easily in the center of a series as can fertilizer applications, and since plots of fair size were needed to obtain representative tillage data, each series of experiments extended over a relatively large area.

Base plot 401, table 1, received no mechanical tillage either in seedbed preparation or cultivation. The old cotton stalks were pulled and broken and scattered over the plot and the weeds were hoed out at planting time with minimum soil disturbance. After planting, the weeds were kept down by hoeing. This plot was planted and fertilized the same as all the other plots. The 5-year average yield of the base plot was 959 pounds of seed cotton per acre and required an average of 74.9 man-hours per acre before planting and 47.2 hours from planting to harvest time. This plot was intended to show the effect of normal cultivation on yield as compared with hoe cultivation on land that has had no seedbed preparation.

Base plot 402 had no soil manipulation in seedbed preparation. However, it as well as all seedbed-preparation plots except 401, received six normal shallow row cultivations. These row cultivations reduced the man-hours required for hoe labor approximately 50 percent. Plot 402 produced an average yield of 1,100 pounds of seed cotton per acre, a gain of 141 pounds over plot 401. It is assumed that the average yield above 959 pounds represents the benefits of tillage.

ANALYSIS OF RESULTS

Though direct comparisons cannot be made of data from different series the approximate value of soil manipulation for any seedbed-preparation plot can be found by comparing the yield with that of plot 402. The calculated horsepower-hours per acre used in seedbed preparation and the time of year when machine operations were performed are indicated and their effects on yield may be compared.

Tables 1 and 2 give results of various methods in shallow-seedbed preparation. The operations in table 1 (series 400) were carried on in the spring while those in table 2 (series 600) were carried on at different seasons. Table 3 (series 500) covers operations similar to those in table 2 but at approximately twice the depth. The preparation methods for the seedbeds were planned to show the following contrasting characteristics at planting time: (1) From no work under the row to an extreme depth of 16 inches of work; (2) from highly pulverized with no clods to very cloddy with 57 percent of the worked soil in clods over 1 inch in diameter as determined by careful sieve analysis; and (3) from beds having an apparent specific gravity varying from 0.9 to 1.7. (Apparent specific gravity is a measure of a soil's relative compactness. It is expressed numerically as the ratio of the weight of a given volume of dry soil to the weight of an equal volume of water.) For the most part the firm seedbeds were produced by working the soil during the fall and winter, and allowing it to settle until planting time. The loose beds were made by preparing them in the spring.

Tables 2 and 3 show that the seedbed-preparation methods in which all work, except shaping the beds, consisted of plowing or breaking between December 1 and February 15 gave high yields. (Note plots 501, 507, 601, and 607.) These operations, performed during a relatively dry season, produced clods that mellowed by spring. The condition of the soil in the plots that produced the highest yields was that having approximately 30 percent of the soil mass to 8 inches in depth in clods over 1 inch in diameter with the spaces between these clods filled with fine soil so as to give an apparent specific gravity of 1.22 in the top 6 inches at planting time and settling to an apparent specific gravity of not more than 1.40 for the layer from 2 to 6 inches below the surface by chopping time. While such a soil structure may be produced in the spring, the data indicate that more beneficial results come from winter mellowing. Winter work also has the advantage of allowing the completion of much of the seedbed work before the spring rush.

It was observed that a number of shallow-machine operations, as used on plot 603, break down the soil's natural granular structure into a finely pulverized condition. Packing rains then produce a close, dense soil structure that tended to break into hard clods with the next tillage operation. The soil classified as Red Bay sandy loam is more impervious to water when overworked than when in a coarse granular state. When fully pulverized it acquires a puttylike consistency and tends to cement on drying, a condition having a detrimental effect on the crop during dry weather.

These observations and results agree with the findings of Yarilov *(11)*. In reviewing the problems of soil structure he states that tillage operations should not be continued until the soil is converted to a powdery structureless state. He says that only a cloddy structure is able to give the soil physical properties in all respects favorable, and that it is indispensable for the normal growth of vegetation as well as for the self-renewal of the soil.

For the most part, all shallow plots yielded about the same. Increasing the depth of operations from 4 inches (series 600) to 8 inches (series 500) produced about 150 pounds more seed cotton per acre, but the deeper work required four-mule or larger units. No subsoil was brought to the surface by the shallow work on series 400 and 600 but 3 or 4 inches of the heavy clay subsoil was turned up by the deeper work on series 500.

SPRING WORK

Generally speaking, spring work refers to operations performed after February 15.

Breaking the middle, often called center furrowing, consists in running a middle breaker midway between the rows and throwing loose soil upon the rows. Breaking the middle 4 inches deep, as on plot 613, produced practically the same yield as no seedbed preparation. This might be expected as the soil in the row was not disturbed. However, this method reduced the man labor as compared with no seedbed preparation (plot 402). Breaking the middle 8 inches deep (plot 513), increased the average yield of seed cotton about 68 pounds per acre. This was no doubt due to the fact that the deeper work threw more loose soil on the rows and that some shear planes or cracks extended under the rows. In farm practice this method is called "planting on the hard." Also in farm practice the new row is located on the old middle, in which case the single operation breaks out the old row and thereby eliminates the labor of pulling the old cotton stalks. Because of the arrangement of plots it was necessary that the rows be in the same place each year which made it impossible to follow the above-described farm practice.

Preparing seedbeds by breaking and rebreaking consists of two operations (plots 509 and 609, tables 2 and 3). First the old cotton row is thrown out with a breaker, then soil is bedded back onto the old row by breaking out the old middles, that is by breaking out the ridges left by the first operation. This method produces a rough seedbed with the old stalks and roots scattered haphazardly throughout. The two middle breaking operations reduced the hand labor in seedbed preparation by removing the old stalks and killing about all of the winter and early spring weeds. In addition, it increased the yield slightly for both depths over the yields for breaking the middles only. Figure 8 shows the appearance of beds produced by this method for shallow work. This method is of special merit when there is a shortage of labor during the spring season as one man can prepare a relatively large acreage. Figure 9, *A* shows the type of seedbed produced by the deep work, immediately after completion; after a hard rain the plots appear as in *B* and after harrowing for planting as in *C*. However for deep work much power is required to smooth down the high beds before planting. This may be reduced by using a wide-wing breaker at a shallower depth for rebreaking. This method was tried in the spring only; thus the cotton was planted on a relatively loose, fresh bed.

Figure 10 shows that stirring the soil reasonably deep below the row assisted in the development of stronger-rooted plants. Figures 10, *A* and *B*, show deep roots on well prepared land while *C* shows that the taproots failed to penetrate the hard soil on land having no seedbed preparation.

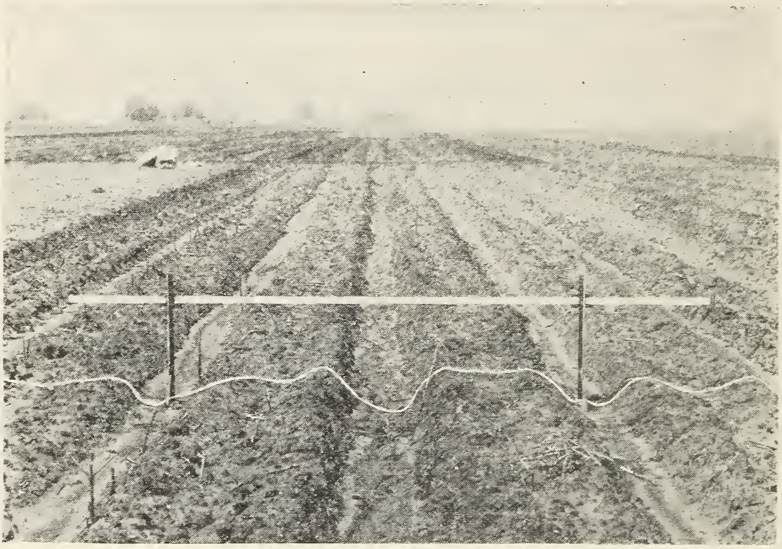

FIGURE 8.—Condition of the beds on plot 609 before smoothing down for planting.

Seedbed preparation by box bedding, as used on plots 608 and 508, is similar to breaking out the row and then breaking the middles except that the soil is bedded back on to the old row after breaking it out, by plowing a furrow slice from each furrow wall before breaking out the old middles. The extra operation did not result in increased yields as may be seen by comparing with methods used on plots 509 and 609. The extremely loose condition of the bed at planting time was a disadvantage both in planting and to the young cotton.

Since subsoiling or deep tilling often is advocated, a 3-inch shovel was run in the bottom of the breaker furrow, made by breaking out the old row, before bedding back. This shovel was run 4 inches deep on plot 605, and 8 inches deep on plot 505, the measurements being made from the bottom of the breaker furrow, thus making the total depth of tillage 8 and 16 inches, respectively. The cloddy soil structure produced is shown in figure 11. Subsoiling reduced rather than increased the yield.

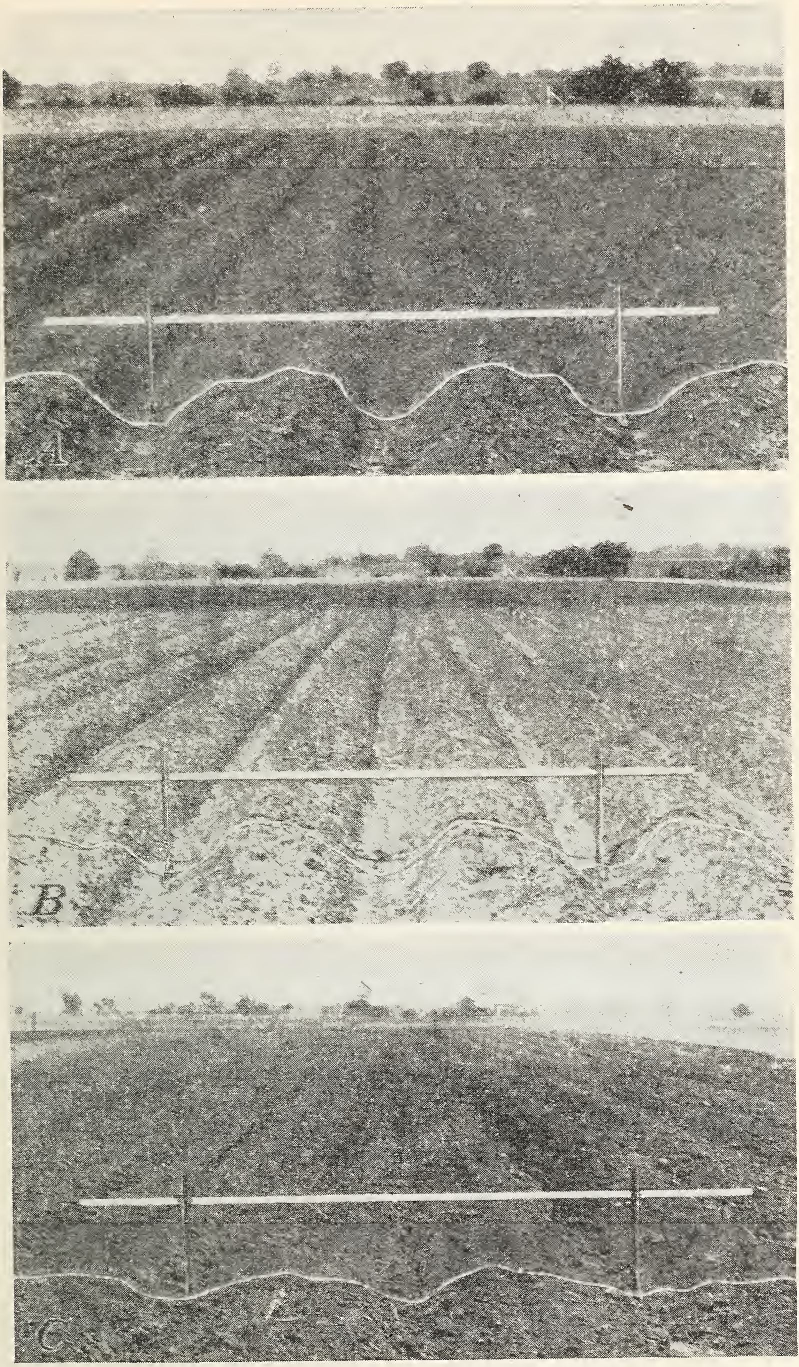

FIGURE 9.—*A*. Breaking out the old row 8 inches deep then breaking the old middles produced high uniformly-shaped beds; *B*, the same beds after settlement caused by spring rains; *C*, appearance of beds after they were harrowed down for planting.

Plots 515 and 615 were disked, plowed, disked, and harrowed in addition to all the operations performed on plots 505 and 605. This produced good-looking, uniform, highly pulverized seedbeds, the kind often recommended. However, normal rains following seedbed preparation caused the soil in these plots to settle rapidly from the very low apparent specific gravity of 1.1 to a surface condition as hard as or harder than the plots receiving no seedbed preparation. This excessive tillage did not produce yields commensurate with the power and labor required.

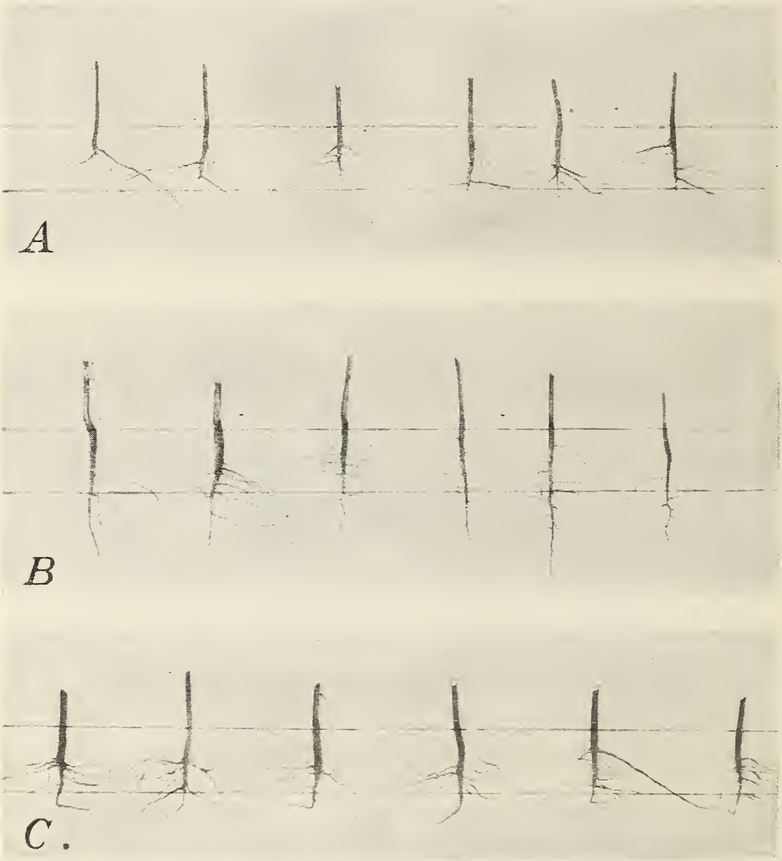

Figure 10.—Typical roots from seedbed-preparation plots. *A*, Plot 609; *B*, plot 509; *C*, plot 402.

Plot 410, double disked March 1 and March 30, produced an average of 1,138 pounds of seed cotton per acre or 38 pounds more cotton than plot 402 with no seedbed preparation. The use of 16.2 mule-hours and 8.1 man-hours for disking replaced all hand work previous to planting and reduced the hoe labor required for keeping the crop clean. Figure 12 shows that the disking operations tend to form a hard layer or plow sole so that the cotton cannot develop a good taproot and the entire root system is confined within a shallow range. Figure 13, *A* shows the roots from a plot receiving 11 seedbed-preparation operations between February 1 and April 10, 10 of which were disking. Continued working of the loose surface soil so sealed the subsoil that taproots were not well developed. Figure 13, *B* shows that proper preparation of the soil induces deep rooting which produces stronger plants.

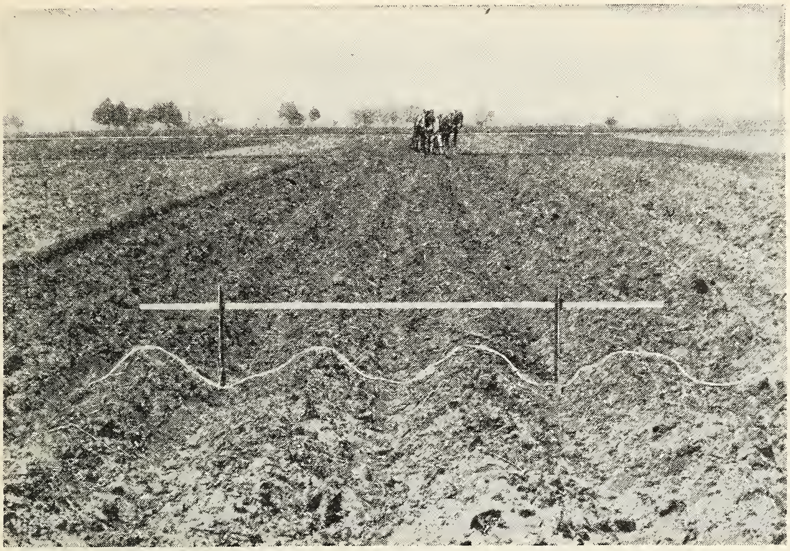

FIGURE 11.—Method used on plot 505 produced a high, cloddy bed but required a relatively large amount of power without a proportionate increase in yield.

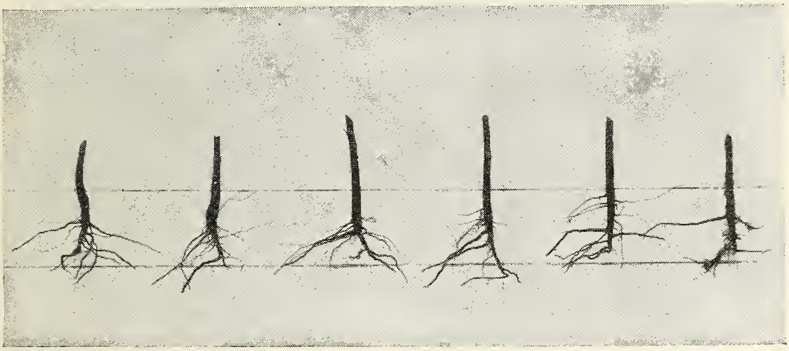

FIGURE 12.—Roots on plot 410 showing effect of double disking.

A series of operations consisting of disking, plowing, double disking, and harrowing, as used on plot 406, and with these operations plus center furrowing (plot 407) resulted in waste of power and labor, as the yield was no greater than for plots on which less work was performed. Bedding similar loose, shallow, spring-worked soil (plot 603) with a cultivator equipped with four disk hillers made a good-looking seedbed, but resulted in restricted root development and low yields. However, the same large number of machine operations at a greater depth (plot 503) did not pulverize the soil the entire depth of plowing as it did on plot 603. This produced a highly pulverized surface soil with a layer of clods imbedded in fine soil below. The roots were able to develop normally in this layer.

Tearing up the surface soil with small shovels spaced 8 to 10 inches apart (plots 408 and 409) increased the yield slightly over plot 402, but required much hand labor in seedbed preparation as the operation did not dispose of the old cotton stalks nor kill all of the weeds.

Preparing a seedbed by throwing soil from two 9-inch furrows 4 inches deep onto the old row (plot 404) produced a lower yield than plot 402 which received no seedbed preparation. The soil manipulation is practically the same as for breaking the middle 4 inches deep (plot 613). The soil in the row is not disturbed, thus the cotton is planted on hard ground. In field practice the farmer usually throws the two furrows on the old row middle thus eliminating the necessity of pulling the old stalks by hand, since they are cultivated out at a later date. This arrangement eliminates most of the 18.6 man-hours per acre used previous to planting.

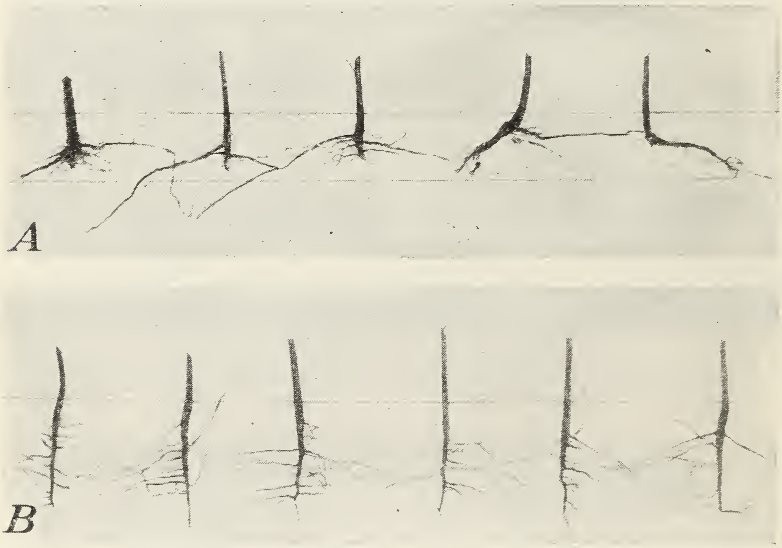

FIGURE 13.—A, Roots on plot receiving excessive spring tillage; B, plot receiving normal spring tillage.

Plot 405 was prepared by throwing out the old row with a breaker, then bedding back onto the old row with four furrows of a turnplow, two on each side. This method increased the yield 99 pounds over no seedbed preparation.

FALL AND WINTER WORK

Methods used on plots 501 and 601 consisted of plowing in the winter 8 and 4 inches deep, respectively, and bedding 3 weeks before planting with a cultivator equipped with four 12-inch disk hillers per row. They required 26.3 and 12.6 horsepower-hours per acre, respectively, and yielded 1,324 and 1,195 pounds of seed cotton per acre. The increases in total yields over base plot 402 are 224 and 95 pounds, respectively. Figure 14 shows these seedbeds after bedding in the spring and just before planting.

Deep winter plowing alone left an open, loosely piled cloddy structure. Weathering action slacked down some of the clods so that by spring the finely granulated portion was washed to the bottom of the furrow. In the spring the unslacked clods were loosely embedded in the fine soil which is the structure found in these experiments on Red Bay sandy loam to be best for cotton production. Bedding this plowed land with a cultivator produced beds that needed little smoothing to put them in shape to plant with conventional lightweight planters and not too high for cultivation. Figure 15 shows the relative development of cotton on plots plowed deep as compared with shallow plowing.

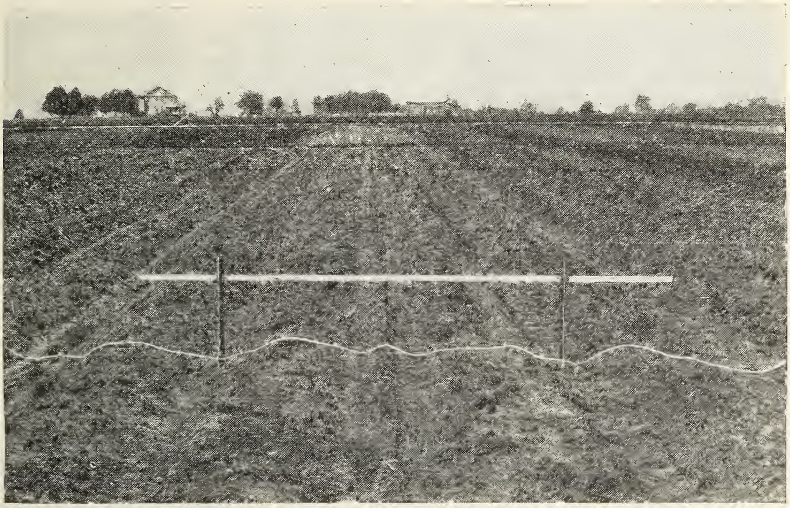

FIGURE 14.—Low beds produced by a cultivator on winter-plowed land after settlement.

Plots 614 and 514 show that working the soil from fall to spring by disking, plowing, and box bedding has no particular merit, as comparable methods having fewer operations, with all seedbed preparation work completed in the winter, produced more cotton.

Breaking the row middle 4 inches deep in the winter (plot 612) did not produce as much cotton as no seedbed preparation. Eight-inch middle breaking in the winter (plot 512) increased the yield very slightly over no seedbed work. The soil surface of these winter-worked plots had flowed together by spring.

Plots 607 and 507 differ from 608 and 508 in that the work was completed in the winter. The old row was broken out in January which is normally a dry season. The edges of the breaker furrow were plowed back after rain had settled the soil thrown up by the breaker and it had dried enough for field work. Finally the old middles were broken out after another similar series of moisture changes. These operations were timed to be completed about February 20. During this period the temperature may drop slightly below freezing between operations. The slight freezing caused a small quantity of the soil to slack off from the sides of a furrow and from the clods. Performing the machine operations under dry conditions tends to break the soil into large clods which are mellowed by the subsequent freezing, wetting, and drying action. The work of rebedding turned most of the fine soil under the rows and placed clods to the sides of the rows. Figure 16 shows the condition of these beds at planting time.

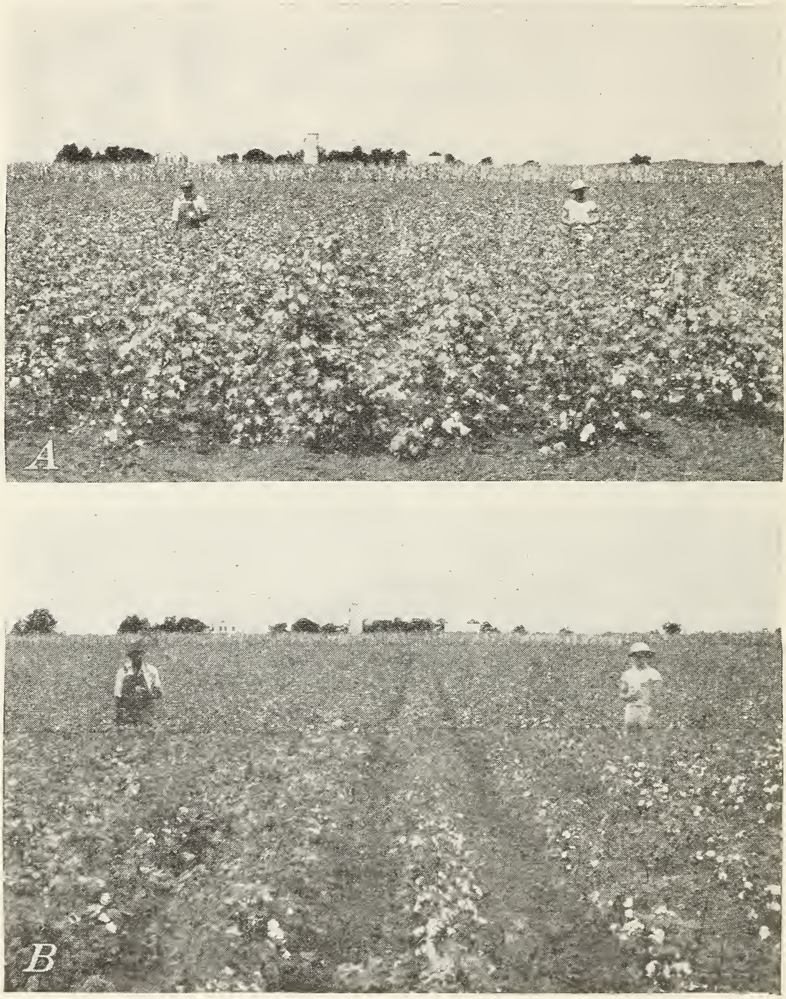

FIGURE 15.—Relative development of cotton on plots prepared by the methods used on plots 501, 505, 601, and 605, (tables 2 and 3): *A*, plots prepared by plowing 8 inches deep; *B*, plots prepared by plowing 4 inches deep.

Another advantage of this method is that the seedbeds were completed during the period when farm work is normally slack. Except for the two-furrow operations, this method would be practical for large-scale power units. Plot 507 had relatively good yields except in 1936 when weed infestation during the late growing season reduced the yield.

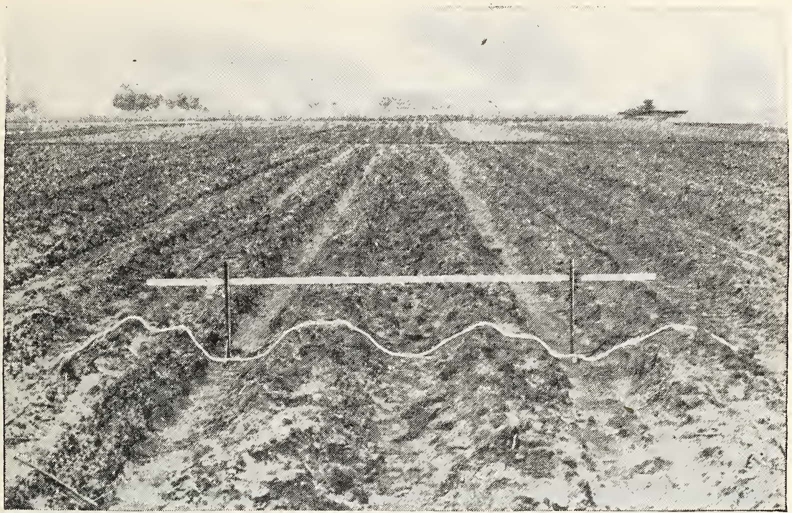

Figure 16.—Seedbed produced by method used on plot 507. All of the work was done in the winter; thus the beds were well settled by planting time.

Subsoiling in the bottom of the breaker furrow before bedding back onto the old row (plots 504 and 604) required a large amount of power but produced less cotton than plots without subsoiling.

WEED CONTROL

The control of weeds by the different methods of seedbed preparation is indicated by the weeds found on the plots in the fall. Prior to 1936 there were few weeds on any plots. However, the dry growing season in 1936 caused the weed seed to lie dormant until the August rains, thus causing a heavy growth of fall weeds on a number of the plots. Measurements made September 9, 1936, showed that 34 percent of the surface of all plots plowed shallow, whether plowed in fall, winter, or spring, was covered with weeds, as compared to 18 percent for the plots plowed 8 inches deep. The following indicates the extent of weed coverage of the plots on which the middle breaker was used: 4 inches deep in the fall or winter, 70 percent; 4 inches deep in the spring, 52 percent; 8 inches deep in the fall or winter, 52 percent; and 8 inches deep in the spring, 33½ percent. The sequence of the operations seemed to make little difference. If the major operations were with a plow the weed control was much better than for tillage at the same depth using a breaker. This is due to the fact that the plow turns the weed seed to the bottom of the furrow where they are too deep to come through or if they do come through, are killed by early cultivations; whereas, the breaker tends to mix the debris throughout the bed leaving some seeds in favorable locations to sprout.

EFFECTS OF CERTAIN SEEDBED-PREPARATION METHODS

The tillage methods used by farmers on the Prattville field for many years before 1932 consisted of working up the beds by operations similar to those used on plot 608, except that it was done at depths varying from 2 to 4 inches, and cultivating frequently by use of a single shovel or sweep on the same plow stock as was used for preparing the beds. The depth of operation was limited to the working capacity of a small mule. These tillage operations had developed a definite plow sole and the cotton plants tended to develop very shallow root systems.

The plots in series 400, seedbeds prepared shallow in the spring, were discontinued in 1937 and this tract was laid off in five strips at right angles to the old plots. No seedbed preparation was performed on one strip, another was double-disked, and three strips were plowed 4, 6, and 8 inches deep. The plots were then classified and grouped as to the type of seedbed preparation used during the previous 5 years as shown in table 4. The results indicate that following shallow spring tillage the effect of good seedbed-preparation methods carries over into the next season as shown by the fact that the yields for the strip that received no seedbed preparation in 1937 were highest on the plots that had been plowed previously and lowest on the plots that had received no previous seedbed preparation. It is indicated also that plowing in early spring practically eliminates detrimental effects of shallow-seedbed preparation in previous years as the yields on the plowed strips varied only slightly.

TABLE 4.—*Effect of five methods of seedbed preparation on the yields of plots receiving the seedbed preparation shown for series 400 during the previous 5 years*

Seedbed preparation for previous 5 years	Plot No.	5-year average yield	Yield on plots that had indicated seedbed preparation in 1937				
			None	2 double diskings	Plowing to a depth of —		
					4 inches	6 inches	8 inches
		Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
None under row	402 and 404.	1,088	1,102	1,178	1,239	1,214	1,250
Plowing and other operations producing favorable soil structures.	405, 406, and 407.	1,197	1,224	1,206	1,284	1,240	1,259
Disking; producing overpulverization and dense subsoil layer.	410, 411, and 412.	1,141	1,144	1,218	1,264	1,256	1,358

Data obtained from one plot not shown in table 4 indicate that overpulverization of the seedbed can destroy in one season the soil-structural conditions produced by good seedbed-preparation methods. This plot in 1934 had been plowed 8 inches deep in the winter, then bedded with a cultivator, and yielded 1,309 pounds of seed cotton per acre. It was then plowed 8 inches deep, followed by 10 shallow operations of disking and harrowing in 1935. The yield was reduced to 1,077 pounds. The seedbed preparations for 1936 and 1937 were the same as for 1934 and the yields were 1,193 and 1,418 pounds of seed cotton, respectively. The average yields for check plots on either side of these plots were 1,361, 1,576, 1,282, and 1,322 pounds, respectively, for the years included. The favorable tillage operations brought the yields back to about the average of the yields of the check for the years 1936 and 1937. This indicates that favorable soil structures can be destroyed and restored again quite rapidly in this soil.

Observations and a limited amount of picking data indicate that the seedbed-preparation methods that produced the higher yields tended to set cotton throughout the growing season, whereas the plots receiving excessive, shallow, or no seedbed preparation set cotton over shorter periods. A drought occurring during July and August in some years caused the cotton on all plots to mature rapidly, and produced small light-weight bolls, especially on the plots not having relatively deep friable seedbeds.

SUMMARY OF SEEDBED-PREPARATION EXPERIMENTS

The purpose of seedbed-preparation work in cotton production is to produce the best soil physical conditions for the germination and growth of cotton.

The desirable physical condition at planting time for Red Bay sandy loam was a relatively low apparent specific gravity with about one-third of the top 8 inches of soil in soft clods embedded in settled finely granulated soil. The structure should be such as will not settle to a high apparent specific gravity by fall.

With seed, fertilizer, and methods of planting and cultivation kept constant, the 6-year average yields varied, due to seedbed preparation methods, from 1,038 to 1,324 pounds of seed cotton per acre. Plots receiving no seedbed preparation produced an average of 1,100 pounds per acre. The methods used on several plots actually resulted in less cotton than no preparation.

Preparation of the seedbed by plowing or breaking the row and then the middle in winter, not only produced the best yields but released labor in the spring for handling feed and food crops.

Excessive tillage in seedbed preparation required much time and power, thus reducing the number of acres a man could handle, and did not increase the yield per acre much above that obtained when there was no seedbed preparation. A loose, overly pulverized, structureless condition was produced in the surface soil which consolidated rapidly after the normal spring rains. These operations tended also to pack the subsoil, producing an impervious layer which did not allow development of a normal root system, slowing up drainage and increasing erosion.

The number of machine operations or the power input into a crop is not a measure of the yield. Maximum yields per acre and returns per man were obtained by use of a few properly executed well-timed operations.

The tillage work under the row is more beneficial than work done in the middles if the soil is not overpulverized. Yield was found to increase with the depth of work under the row down to 8 inches. Subsoiling did not increase the yields.

Deep plowing gave the best control of weeds. Shallow working or ridging the soil did not cover weed seed deep enough to prevent their germination.

Periods of moisture deficiency reduced yields. Tillage methods that increased the moisture-holding capacity of the soil tended to increase yields.

COTTON PLANTING

A survey of cotton-planting methods used in 1930 by farmers in seven States showed that no attempt was made to adapt methods to the soil type or field condition. Frequently different methods were used by neighboring farmers having nearly identical conditions. A large percent of the farmers stated that their system worked well only part of the time. One of their major problems was to get a stand on the first planting. The farmers interviewed varied the depth of planting with the season. Early cotton was planted about one-half inch deep; the depth was increased to approximately 1 inch for midseason planting and to 1½ to 2 inches for late-season plantings. These depths gave favorable stands if weather and soil conditions were favorable, but seeds planted shallow do not germinate if the ground dries out soon after planting and if planted deep and heavy rains follow, they may rot or a crust may form which the young plants cannot break. The strength of soil crusts has been determined by Carnes (*2*). Another hazard is the fact that the young plants are all in the same stage of growth so that cold weather or a disease might seriously damage the entire stand.

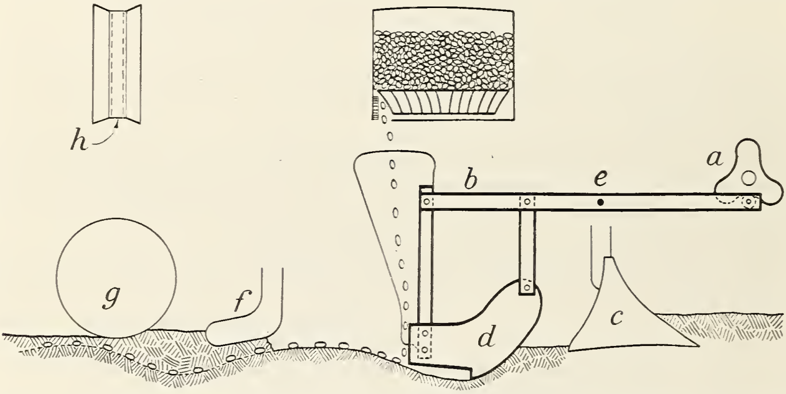

FIGURE 17.—Diagrammatic sketch of variable depth cotton planter: *a*, Cam; *b*, lever arm; *c*, sweep; *d*, variable-depth furrow opener; *e*, pivot for lever arm; *f*, covering spoon; *g*, open surface press wheel; *h*, front view of press wheel showing shape.

The uncertainty of getting a stand from the first planting limits the number of acres that can be handled by one man, since allowance must be made for the possibility of replanting. Replanting is often done by using all available labor and power and neglecting other crops. Thus, to the cost of seed and labor for replanting may be added the loss of feed and food crops and the loss of yield due to planting late. In some cases the quality of the lint is lowered because of the scarcity of good seed. This last point is of especial importance to farmers in one-variety areas.

The variable-depth principle of cotton planting was developed by the Bureau of Agricultural Engineering to help overcome the difficulties in getting a stand. It differs from the conventional constant-depth planter in that the opener for the seed is caused to move up and down, planting some of the seeds shallow, some of them deep, and some in between (fig. 17). The planter is so designed that the distance from crest to crest of the undulations is equal to the desired distance between hills. In planters equipped with runner-type openers, the variations in depth may be caused by the use of cams, cranks, or eccentrics. Disk openers may be notched to produce this effect. The variations in depth and spacing are determined for a given planter by the design of the cams or other mechanism. The merit of the variable-depth method of planting is clearly shown by the fact that on only 5 plots were there partial failures to obtain a stand during the 6 years of this study. This is remarkable because the seedbed preparation produced 39 types of beds on the Red Bay sandy loam soil varying from extremely loose to hard ground, and plantings were made throughout the planting season from extremely early to late. The failures resulted from very early plantings on plots where the seeds were not firmly covered. This method of planting has helped materially with the seedbed-preparation and cultivation experiments as it has not been necessary to consider the factor of variation in stand.

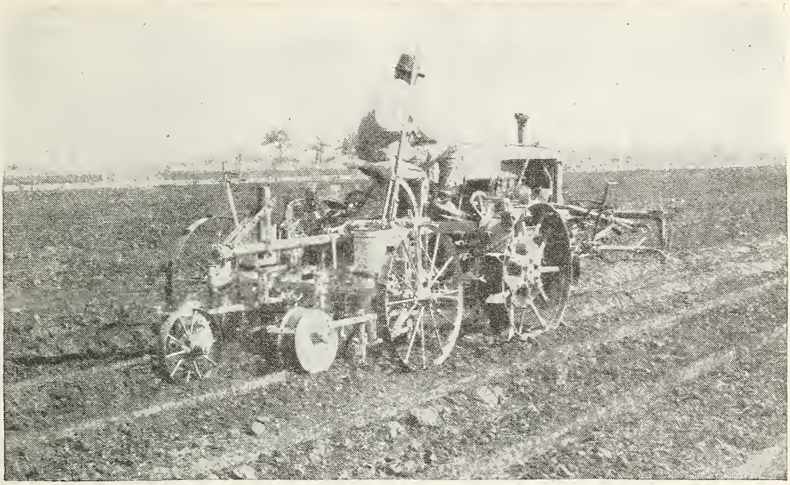

FIGURE 18.—Experimental cotton planter.

The cotton-planting experiments were designed to determine also the effects of firming the soil around the seed and firmness of bed both on stand and on the yield of cotton, using variable- and constant-depth planters. The equipment for these studies consisted of commercial one-row, constant-depth planters, one-row planters equipped with variable-depth attachment, and an experimental planter built on the frame of a heavy two-row planter. This experimental planter (fig. 18) was designed to level the bed ahead of the planting mechanism and to use any one of the desired methods or combinations of methods of seed placement and covering. It was used during 1934, 1935, 1936, and 1937.

In this experiment cotton was planted every few days from early in the spring until later than normal. It was planted on fresh and settled beds on each date, with some beds shaved off with a sweep ahead of the planting mechanism and others dragged down by use of a float. Various combinations of covering arrangements and press wheels were used with both constant and variable-depth plantings.

These experiments show that variable-depth planting with a seed press wheel developed by Camp and Townsend (*1*) and press wheel for covering gave the quickest germination. However, there was a high mortality of early plants so that the variable-depth planter without the seed press wheel had the advantage in the end. Under favorable conditions, constant-depth planting gave the best stands, but these conditions may prevail only a few days during the planting season. A planting made April 21, 1933, was followed by a hard rain and warm weather that dried the surface soil rapidly, forming a heavy, strong crust. Weather conditions caused the cotton to germinate quickly. The shallow seed of the variable-depth planting started coming through before the crust was well formed. This started a break over the row so that the seed coming from progressively deeper parts of the planting acted as a wedge, breaking the crust. The crust was light and relatively soft when the first plants came through but was nearly one-half of an inch thick and very hard when the last plants broke through. Cotton planted 1 to 1¼ inches deep, constant depth, at the same time failed to give a good stand because the soil crust was too strong by the time the plants were ready to come through.

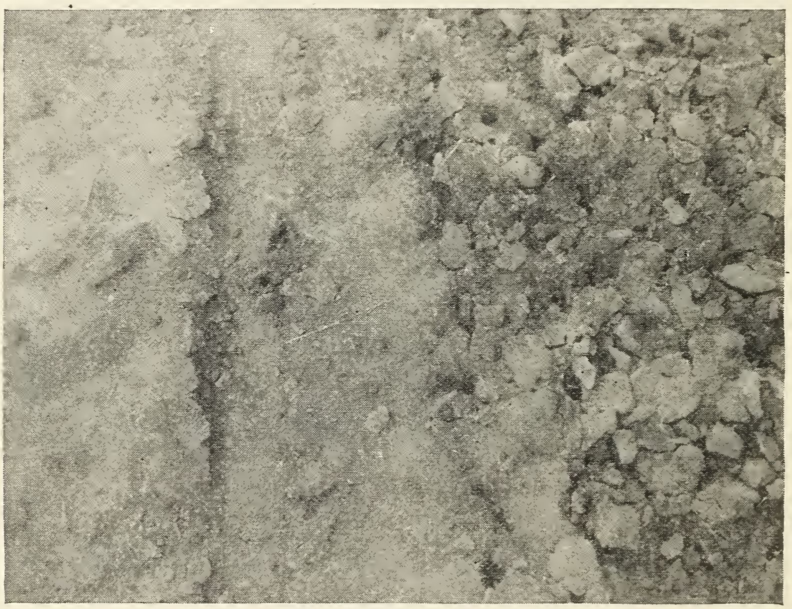

FIGURE 19.—Crust broken by rotary hoe.

The use of a rotary hoe or other similar tool as a crust breaker would be of much value under this condition, as is shown in figure 19. The crust shown on the left prevented constant-depth plantings from coming through (the crook had straightened out). The right side of figure 19 shows how the soil crust was broken up by the rotary hoe. A perfect stand of cotton was up on the entire field 2 days later, but a strip left for observation had to be replanted.

These experiments show that list planting is to be avoided on lands having poor surface drainage and that crust easily. The concave crusts in a furrow are most difficult for the plants to break, as may be seen from a study of figure 20. The experiments show also that the drag harrow, rotary hoe, and weeder vary in their efficiency as crust breakers. The drag harrow and weeder should be used while the crust is still soft or the young plants may be pulled off with the crust. The rotary hoe does best work if used before the crust is fully formed, and can be used safely on relatively hard crusts as the revolving teeth punch holes in the crust and their slight prying action breaks it up into small clods that healthy plants can dislodge easily. Row

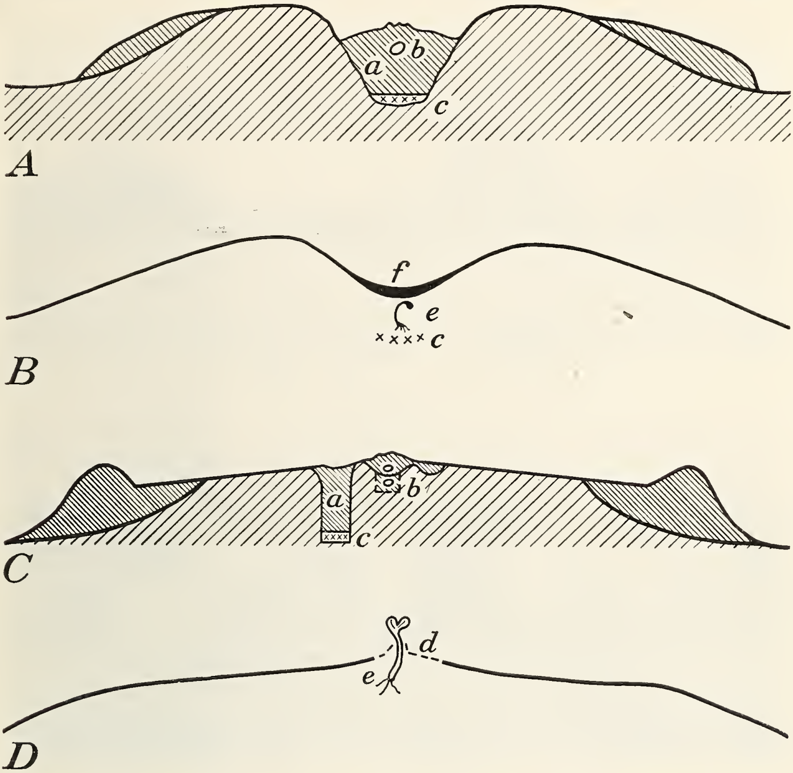

Figure 20.—Diagrammatic cross section of cotton rows comparing shapes of beds. *A*, A conventional planting method in which the furrow is partly filled and the cotton planted on loose soil above the fertilizer; *B*, rains tend to wash fine soil over row and form a hard crust; *C*, bed cut to level and planted variable depth with fertilizer below and at one side of the seed; *D*, weathering rounds the bed so that drainage is away from the row and only slight crust is formed: *a*, Loose soil; *b*; cotton seed; *c*, fertilizer; *d*, thin soil crust; *e*, seedling supported on loose soil; *f*, heavy soil crust.

cultivation before the plants are up can serve this same purpose if done very carefully and rotary shields are used close to each side of the row and set deep enough to pierce the crust.

Results of the cotton-planting experiments show that getting a stand is not the entire problem, as factors that affected the seedling stages were reflected in final yield. The method that gave the highest number of young plants did not always give the best yield. The work at the Alabama Agricultural Experiment Station (*5*) shows that with rows 3½ feet apart best yields are obtained with cotton hills spaced approximately 18 inches apart with 1, 2, or 3 plants to the hill. It is recommended that there should be no skips over 36 inches. This gives a variation of from 13,000 to 20,000 plants per acre without affecting the yield if the plants are uniformly distributed. Thus the vigor of the plants is important rather than merely a large number. The variable-depth method of planting aided materially in obtaining a uniform spacing as plants in some part of the planting cycle usually grew better than the others and the cotton-chopping crew naturally left the more vigorous ones (fig. 21).

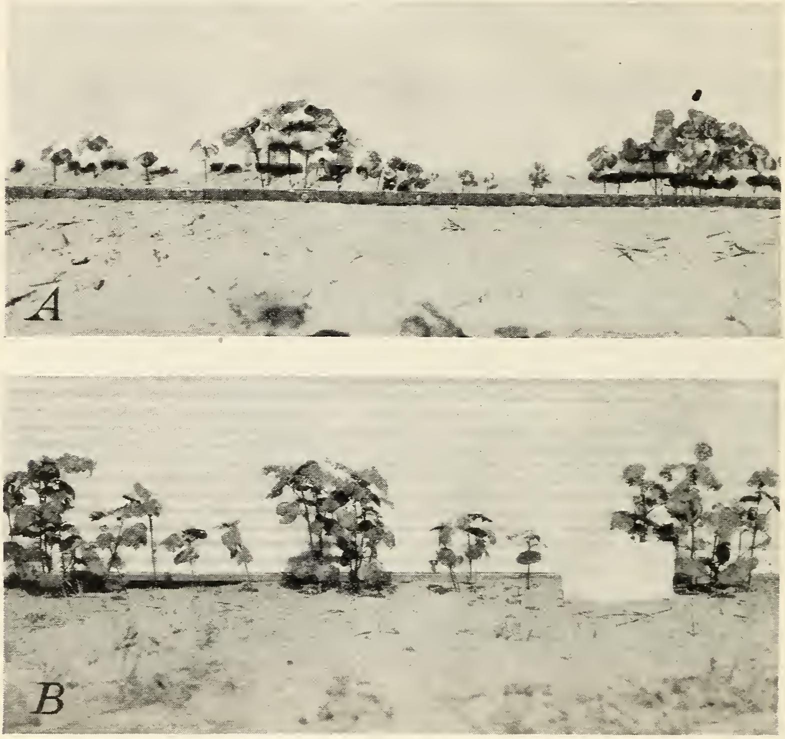

FIGURE 21.—Young cotton plants from variable-depth planting: *A*, Appearance of plants shortly after emergence; *B*, appearance of plants on June 12.

It was found that the age of bed in this soil should vary with the type of planting equipment and method of preparation. Disked land gave best results if planted as soon after bedding as possible, due to the combination of a highly pulverized surface with a dense layer below which hinders the entrance of cotton roots. Planting immediately after preparation of the beds gives the roots a chance to established themselves in the subsoil before it becomes too tight. The results were much different on plowed land. Best results were obtained with light-weight planters if the beds had 10 to 20 days to settle before planting. Older beds produced lower yields due in part to the difficulty of getting light planters to penetrate firm beds. Beds 15 to 50 days old gave about equally high yields when the heavy planter equipped with a sweep for leveling the bed was used. This planter placed the seed at the desired depth in the firm beds and good yields resulted.

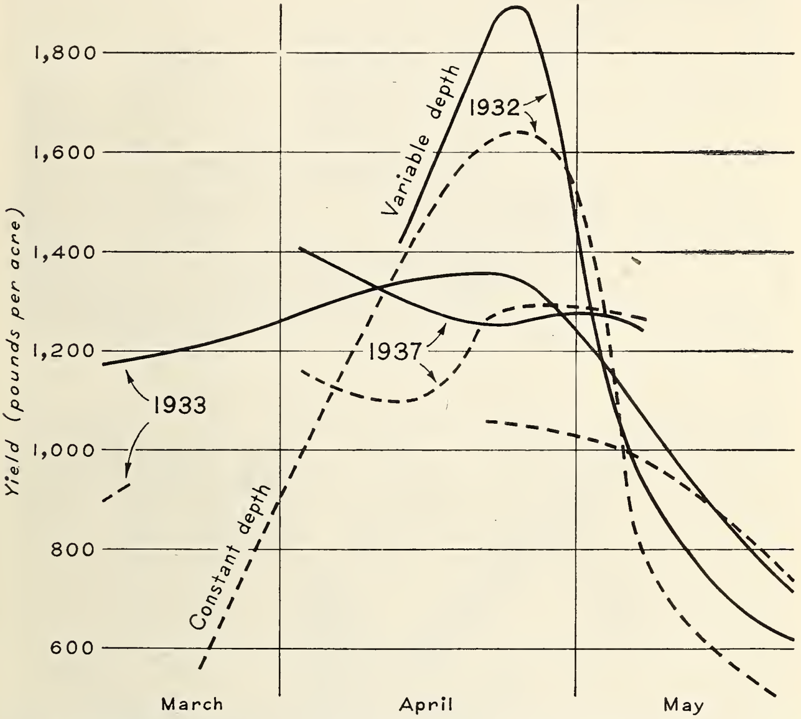

FIGURE 22.—Comparison of yields of cotton planted with light-weight, walking, variable- and constant-depth planters on land that had been plowed.

Figure 22 shows the yields for variable- and constant-depth plantings made from March to May 1932, 1933, and 1937. These results show that variable-depth planting gave higher yields than constant depth for the early plantings. The method of planting made little difference for plantings later than April 25.

Figure 23 shows that leveling the seedbed with a sweep gave higher yields than using a drag harrow because the harrow tended to destroy the physical condition of the soil produced by settling. Figure 23 shows also a definite relation between yield and minimum temperatures following planting. The low yields for cotton planted about April 7 were caused by the cold weather a week or so after planting. The extremely low temperatures for April 12 to 17 caught some of the young plants just as they were emerging. Many such plants were killed, but enough came from other depths to give a stand.

Manufacturers of farm machinery are convinced of the value of the variable-depth method of planting cotton and have developed variable-depth attachments for their mule and tractor planters. Some use the oscillating shoe openers as shown in figure 24, *A* and others use a notched-disk arrangement as shown in figure 24, *B*. This latter arrangement varies the depth by steps in sawtooth fashion (fig. 25) instead of in waves as shown in figure 21. Figure 25 shows also the relative locations of seed and fertilizer put down with a commercial unit.

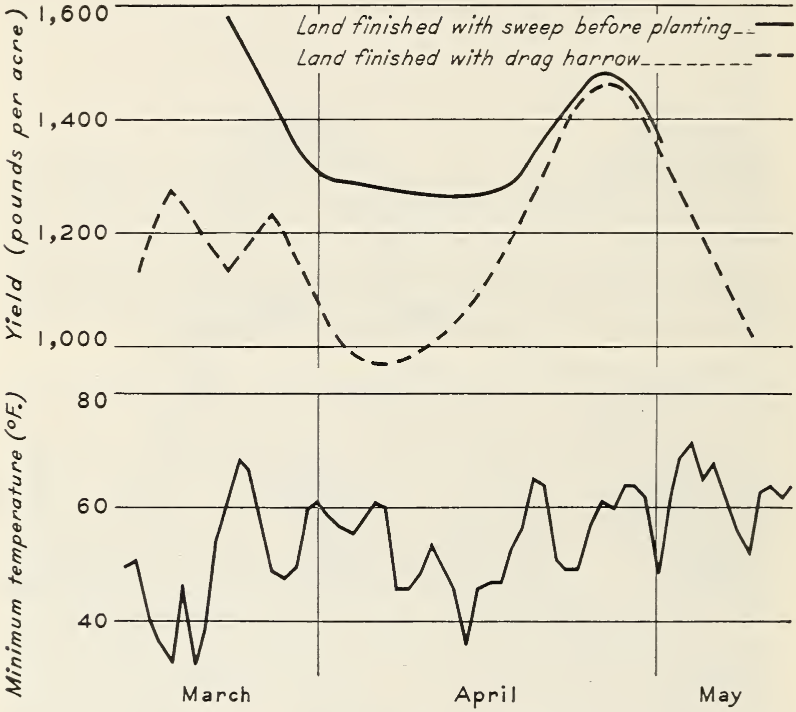

FIGURE 23.—Value of leveling bed with sweep (which does not compact or pulverize the soil) over tearing beds down with the drag harrow, and relative effects of low temperatures 7 to 10 days after planting on yields for both types of beds.

SUMMARY OF PLANTER TESTS

A planter must have sufficient weight, strength, and contact with the ground to hold the opener to the desired depths in the soil.

A sweep mounted on the front of the planter to cut the bed to the desired height improves the yield of seed cotton, removes weeds and trash from the row, and makes possible a better job on the first cultivation.

No one depth is optimum for planting cotton. Constant-depth planting should be varied from one-half inch in March and early April to about 1½ inches after May 1 for plantings on Red Bay sandy loam in central Alabama.

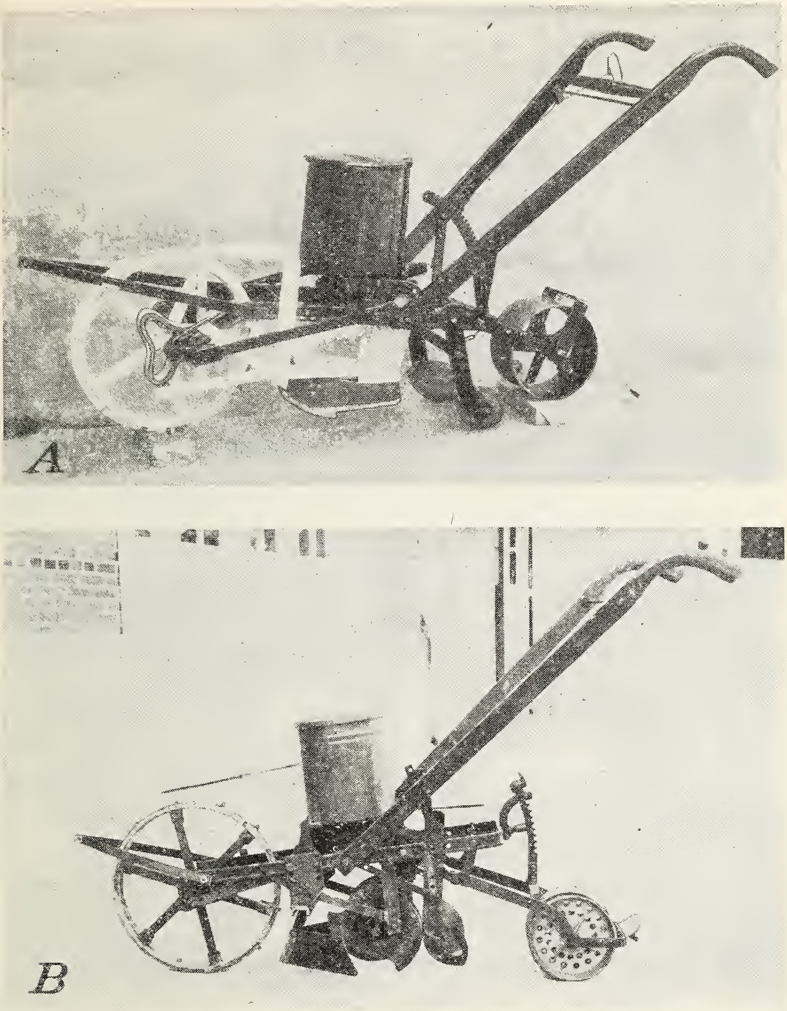

FIGURE 24.—*A*, One-row cotton planter equipped with oscillating-shoe variable-depth planting attachment. *B*, One-row cotton planter equipped with notched-disk opener to give variable-depth planting. Note also the wing-sweep arrangement for leveling the bed ahead of the planting mechanism.

The variable-depth method of planting practically insures a stand of cotton on the first planting even under the very unfavorable conditions often encountered in early spring.

Cotton planted at varying depths gave better stands where soil crusts formed than cotton planted at constant depth, as conditions favorable for development of crusts caused seed planted shallow to germinate and emerge before the crust was fully formed.

The seed press wheel helped to insure a quick stand, but tended to reduce yields, so it is not recommended for the conditions encountered in this experiment.

A surface press wheel should be used throughout the season. The open-type wheel gave best results if the soil was inclined to crust and the closed or solid-tire type was best under certain dry conditions.

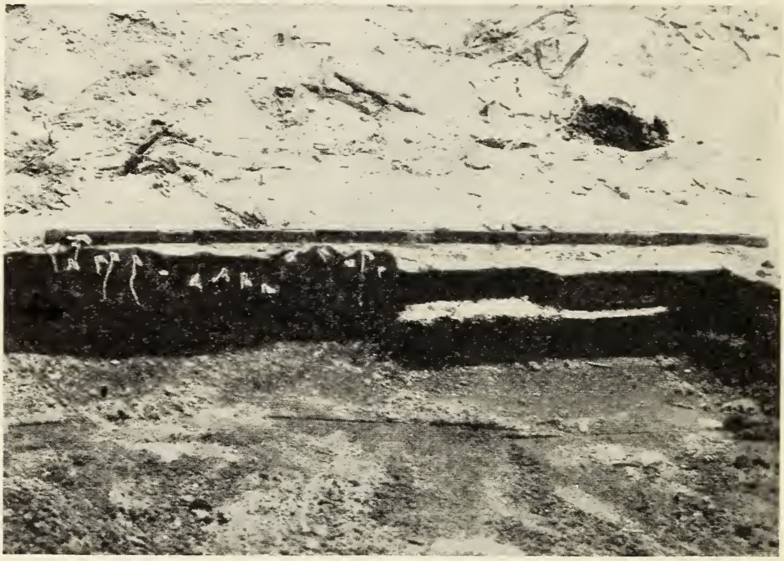

FIGURE 25.—Section of a row planted with the notched-disk-type variable-depth planter. Note the variation in depth of seed. In this case the shallow seeds are up. Note also the band of fertilizer slightly below and to one side of the seed.

The covering spoons or disks should be arranged to throw a uniform amount of soil onto the row.

COTTON CULTIVATION

Cotton-cultivation methods and equipment, like those for seedbed preparation, vary widely. The differences in soil physical characteristics and the prevalence or absence of certain types of weeds are ample justification for much of this diversity. However, many of the cultivation practices seem to be continued from force of custom and have no scientific basis.

The purposes of the study of cultivation methods were to determine the functions of cultivation and how these functions may be accomplished most economically.

Cultivation methods fall into two general classifications—row cultivation and cross or angled-to-the-row cultivation. Row cultivation methods were conducted on series 100 and cross-row cultivations on series 300. The operations, average man-hours required, and the average yields of the plots are shown in figure 26. All factors other than cultivation were kept constant so that variations in yields would be due to cultivation. Records were made of (1) the hoe labor required to supplement the planned machine operation, (2) the weed infestation measured by actual weed counts, (3) the power required for the machine work, and (4) yields. The cotton was planted with the experimental unit described earlier in the report. The data for each cultivation series were handled separately and no adjustments were attempted to compensate for the soil variations from series to series.

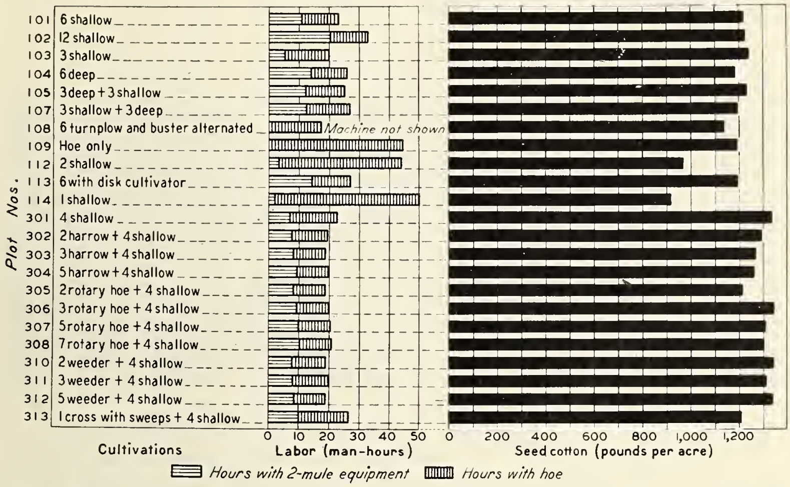

FIGURE 26.—Labor and yield of seed cotton under different cultivation methods. The man-hours required for operating cultivating equipment are separated from those required for hoeing except for plot 108. On series 300 the shallow cultivations are with the rows and the other cultivations are across the rows. The graph is based on the average of 5 years' work except plots 112, 113, 114, 308, and 313 which are for 4 years.

Such power and machine units were used as were available and would do the required work. In interpreting the data, it is necessary to assume that all power units, whether one-mule, two-mule, or tractor, are capable of producing much the same effects on the cotton crop.

The Prattville experimental plots were not greatly infested with Johnson, Bermuda, or nutgrass, and the results obtained cannot be duplicated on fields much infested with these grasses. However, there was an abundant infestation of crabgrass and of practically all upland weeds common to the South; hence this field is representative of conditions found on average well-cared-for cotton lands.

ROW-CULTIVATION STUDIES

Row-cultivation experiments on series 100 were designed to show the effects of depth and frequency of cultivation with conventional implements. Table 5 gives the methods and the average yields.

TABLE 5.—*Yield of seed cotton per acre under different methods of cultivation on plot series 100, 1932–36*

Plot No.	Cultivation methods[1]	1932	1933	1934	1935	1936	Average
		Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
101	6 shallow cultivations, sweep[2]	1,429	1,092	1,311	1,286	1,003	1,224
102	12 shallow cultivations, sweep	1,439	1,096	1,307	1,290	994	1,225
103	3 shallow cultivations, sweep	1,522	1,077	1,254	1,364	983	1,240
104	6 cultivations, deep, 5-inch shovels[3]	1,377	1,013	1,281	1,336	847	1,171
105	3 deep cultivations followed by 3 shallow	1,326	1,032	1,252	1,357	1,012	1,196
107	3 shallow followed by 3 deep cultivations	1,371	1,064	1,249	1,236	957	1,175
108	Turnplow and middle breaker cultivation[4]	1,260	1,030	1,163	1,302	878	1,126
109	Hoe only	1,223	1,078	1,381	1,199	1,099	1,196
112	2 cultivations (shallow)	--------	800	1,036	1,212	705	[5] 938
113	6 cultivations (shallow) with disk cultivator[6]	--------	1,112	1,235	1,350	927	[5] 1,156
114	1 shallow cultivation, sweeps	--------	803	712	1,252	818	[5] 896

[1] The seedbed preparation for the entire series consisted of winter plowing 6 to 7 inches deep and bedding with cultivator 2 to 3 weeks before planting.

[2] Equipment: First cultivation two 14-inch disk hillers, two 8-inch sweeps, and two 10-inch sweeps; second, third, and fourth cultivations—two 8 inch sweeps, two 10-inch sweeps and two 14-inch sweeps; fifth and sixth cultivations—two 10-inch sweeps and two 16-inch sweeps.

[3] 5-inch diamond-point shovels set 5 to 6 inches deep.

[4] 6-inch plow and 8-inch middle breaker used alternately.

[5] 4-year average.

[6] Conventional disk cultivator with three 16-inch disks in each gang.

Shallow cultivation, using sweeps, is the most common of the improved methods of row cultivation. It was found that the cotton needed to be cultivated only enough to control weeds. One or two cultivations a season were not enough to keep down the weeds (except in 1935) as shown by the relatively low yields for plots 112 and 114. Of the shallow-row cultivations, three well-timed, shallow cultivations produced the highest 5-year average yield, 1,240 pounds of seed cotton per acre. Six and twelve cultivations cut the 5-year average yield 16 and 15 pounds of seed cotton, respectively, below that for three cultivations. The saving of about 2 hours per acre of summer hoe labor on plots 101 and 102 was not sufficient to pay for the extra cultivations and loss in yield. Note figure 27.

A comparison of the following methods of cultivation indicate and evaluate its dual purpose: (1) Weed control, and (2) soil working. Hoe cultivation sufficient to keep down weed growth but not to disturb the soil produced an average yield of 1,196 pounds of seed cotton per acre (plot 109). Plot 101, with its six shallow cultivations (used for cultivation on all seedbed-preparation plots, series 400, 500, and 600) produced an average of 1,224 pounds of seed cotton per acre. The yield data for poor weed control (one cultivation only) on plot 114 shows a wide variation for the 4 years. During 1933, 1934, and 1936, the late-spring and early-summer seasons were favorable for the growth of weeds so that by August 30 the weeds were knee high in this plot and the average yields were at the rate of only 803, 712, and 818 pounds of seed cotton per acre, respectively. Dry weather during this period in 1935 prevented weed growth after the first cultivation and the yield was 1,252 pounds. Hence, keeping down the weeds, as was done by hoeing on plot 109, yielded 275, 669, and 281 pounds more of seed cotton per acre during 1933, 1934, and 1936, respectively, than was obtained by one cultivation.

The 5-inch diamond-point shovels used for the deep work (plot 104) required about 50 percent more power than sweeps cutting ½ to 1 inch deep, and the plots so treated produced less cotton than plots receiving an equal number of shallow cultivations (plot 101).

Plots 105 and 107 show that all deep-cultivation work, if practical, should be on the first cultivations and not the last. Cutting of established roots may have caused the lower yield on plot 107.

Farmers with very little equipment are forced to use the method employed on plot 108. The soil is first thrown away from the row with a small turnplow, and thrown back to the row on the next cultivation. Then a small breaker is used to work the row middle. These two implements are alternated throughout the cultivating season. The 5-year average yield for this method was 70 pounds of seed cotton less than for hoeing only and 114 pounds less than the yield for three

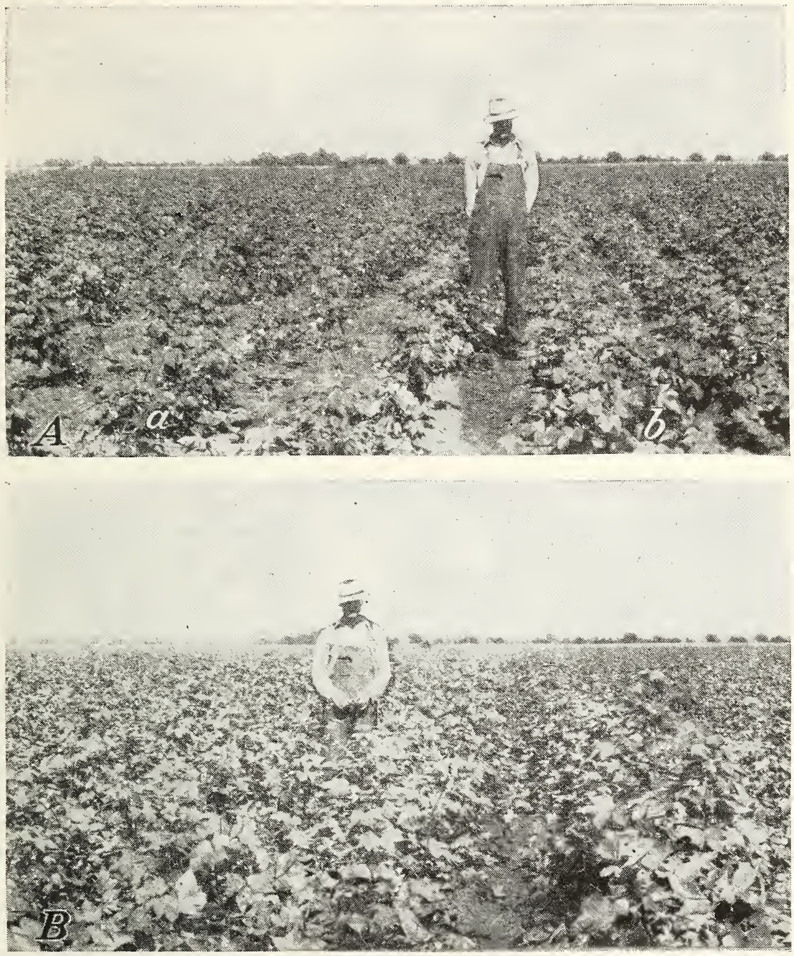

Figure 27.—*A*, Cotton on plots 114 and 115, on August 15, 1934. Plot 114 (*a*) had only one cultivation; plot 115 (*b*) received six deep-disk cultivations. *B*, Cotton on plot receiving six shallow cultivations, photographed August 15, 1934. Comparison of this cotton with that in *A*, shows the value of thorough tillage in both seedbed preparation and cultivation.

shallow cultivations. Disk cultivation, plot 113, produced yields each year that compare favorably with the yields for shallow cultivation with sweeps.

CROSS-ROW CULTIVATION STUDIES

The farmer who plants a high percentage of his cultivated land in cotton and other row crops normally needs much labor during the chopping period. Since cotton is a cash crop, the farmer will either neglect his farm food and feed crops, keep extra labor on the farm, or hire outside labor. In any case, the net farm income is reduced. Cross-row cultivation offers a possible aid in the solution of the problem, but farmers believe it to be injurious to the crop.

The cross-row cultivation experiments described herein were designed to determine whether or not injury to crops results from such cultivation, its effect on chopping dates, and to find, if possible, a substitute for early row cultivations. It was hoped that methods could be found whereby the chopping and cultivating can either be reduced or spread over a longer period and thereby aid in the development of a balanced diversified farming program.

The seedbed preparation, planting, seed, and fertilizer were uniform for the cross-row cultivation studies. The rows ran across the plots and were continuous from plot to plot for the full length of the series. This enabled planting and late row cultivations to be made without turning at the side of each plot. A spring-tooth weeder, a drag harrow, and a rotary hoe were each used two, three, and five times on different plots. The rotary hoe and weeder were used seven times on some plots. It was planned to have the last cross-row cultivation, on plots receiving two, three, and five operations, completed about 40 days after planting. The operations for three times over were about equally spaced during the 40-day period unless a heavy rain or excessive growth of young weeds made it advisable to push one operation ahead a little. The plots with two operations were cross-cultivated at the time of the first and last cultivation on the plots receiving three. Five cultivations were obtained by putting one extra operation between the first and second and another between the second and third cultivations. The rotary hoe and weeder were used once before and once after all cross-row cultivations for the methods receiving five cross-row operations, making a total of seven operations. This made the last cross-row cultivation for this group about 45 days after planting.

After all cross-row cultivations were completed, the cotton was barred off, chopped to the desired stand and given four shallow row cultivations. The barring off was accomplished by equipping the cultivator with a disk hiller set to cut a small bar furrow on either side of the row and two 8-inch and two 12-inch sweeps per row set to sweep the soil back into the bar furrow and completely clean the weeds from the row middle. This one time over, therefore, accomplished three purposes: (1) Barring off, (2) sweeping back, and (3) cultivating the middles. Sweeps only, set as for plot 101 (table 5), were used for the last three row cultivations. It was about 50 days after planting before the cotton was chopped to its final stand. Cross-row cultivation did not affect the total number of hours of hoe labor required to keep the cotton clean but did reduce the number of row cultivations necessary and lengthened the chopping period from the usual 20 days to approximately 40 days.

At the completion of the cross-row cultivations the cotton varied in height from about 6 inches to 12 inches, caused by variable depth planting and the more rapid growth of the healthier plants. It was only natural for the chopper to leave the larger plants for the stand. It is generally believed among farmers that such large cotton is beyond the range of cross-row cultivation, and some of the cultivations caused the cotton to look as though it had been through a hailstorm but these effects were only temporary.

EFFECT OF CROSS CULTIVATION ON STAND OF COTTON

The degree of damage to the cotton crop by cross cultivation with the drag harrow, rotary hoe, and the weeder depends largely upon the stand of the cotton and the seedbed condition at the time of these machine operations. Seedbeds that were more or less smooth or with a slight crown of soil over the row showed best results for cross-row cultivation. These operations may cause considerable damage to the crop on loose seedbeds that shift easily as many plants may be dragged out or covered. If the cotton is planted in a small list or furrow (that is, lower than the soil adjacent to the row) there is a tendency, especially under loose or cloddy soil conditions, for cross-row cultivation, particularly with the drag harrow, to knock or drag soil into the row, often covering up much of the young cotton. Another disadvantage of planting cotton in a furrow is that the teeth of the cultivating unit do not reach the row, hence do not break up any crust that might have formed there.

The action of the machine in cross cultivation of very high beds was too drastic; in addition, high beds caused excessive and destructive strains in the implement as it traveled over the ridges, especially at high speeds, and made uniform working impossible.

TABLE 6.—*Plants surviving cross-row cultivation, plot series 300, in 1932 and 1934–36*

Cultivations (number)	Implement	1932	1934	1935	1936	Cultivations (number)	Implement	1932	1934	1935	1936
		Percent	*Percent*	*Percent*	*Percent*			*Percent*	*Percent*	*Percent*	*Percent*
2	Drag harrow	80.5	69.0	67.2	37.0	7	Rotary hoe	------	53.8	59.8	29.7
3	do	61.1	54.8	68.1	29.2	2	Weeder	96.6	87.2	112.3	38.2
5	do	48.5	[1] 36.6	70.7	29.4	3	do	75.0	79.8	104.8	35.6
2	Rotary hoe	81.6	82.6	89.0	40.7	5	do	61.2	54.4	93.4	39.8
3	do	80.5	80.7	96.1	32.5	7	do	------	------	72.6	28.4
5	do	90.9	58.1	87.0	37.5		Cross blocked	------	------	------	21.8

[1] Rotary hoe used for last 3 cross-row cultivations.

All cross-row cultivations tended to kill or pull out the weaker plants, leaving the healthy plants with less competition, and thus making it easy for the choppers to leave the most vigorous ones. The drag harrow caused the greatest damage to plants having normal roots, the rotary hoe caused less damage, and the weeder caused the least damage. Plants that were directly struck by the wheels, the mule's feet, or long sliding parts of the machine were usually killed or badly stunted. With a full stand of cotton plants the damage thus caused is of minor importance.

Effects on soil crusts are discussed in connection with planting studies (p. 32).

Cross-row cultivation under the very loose soil conditions prevailing in 1934 resulted in more damage to stand than in the other years. The action of the drag harrow was so drastic that it was necessary to modify the experiment by using a rotary hoe for the last three cross-row cultivations on the one group of plots. Figure 28 shows the destruction of cotton plants resulting from cross cultivation. The average number of plants per 100 feet of row on plots receiving no cross-row cultivation was about 850 for 1932, and 1935, 790 for 1934, and 1,250 for 1936. Table 6 shows the percentage of the original plants that survived the several machine operations. These percentages are based on the average number of plants per equivalent length of row in the plots receiving no cross-row cultivation. Thus the values are only relative. The low values for the 1936 season were due to the fact that the base counts were made about May 12 at the time the no-cross-cultivation plots were chopped and there was no measurement of the plants that perished between then and June 1 when the cross-cultivated plots were chopped to stand, whereas in previous years all plots were chopped at the same time (about June 1).

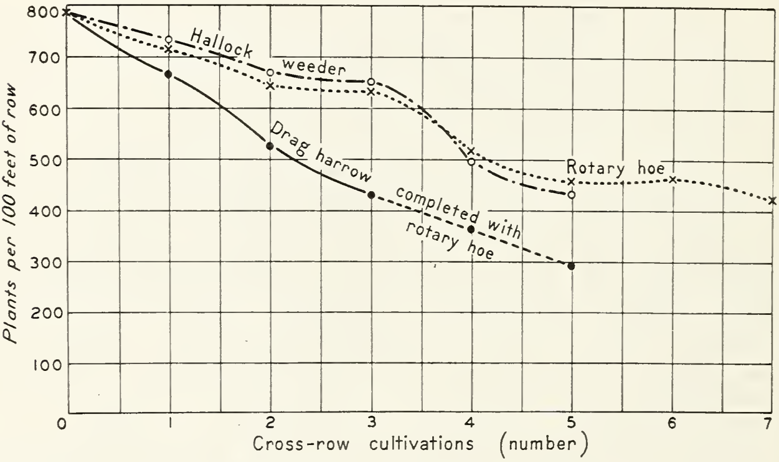

FIGURE 28.—Curves showing reduction of plants per 100 feet of row in 1934 due to one to seven cross-row cultivations with various tools.

All three cross-cultivation implements were effective on weeds growing from small seeds. These tools are of most value if used before the weeds have established a good root system; they are of little or no value for the control of Johnson grass, nutgrass, Bermuda grass or bindweed. Established weeds can be controlled only by direct cutting, pulling, or covering with soil.

YIELDS OF CROSS-CULTIVATED PLOTS

Table 7 gives the 5-year average yields per acre of the experiments on plot series 300 where the principal seedbed preparation was deep plowing. The yearly variation in results show that cross cultivation should not be a set rule. If there are no weeds or tight soil crusts to break, cultivation may do more harm than good. In 1935 and 1936 the seedbed preparation on series 300 was changed on one-half of the area from 6-inch plowing to breaking the rows and bedding back by breaking the middles 9 inches deep in the spring. The operations as performed brought a large quantity of subsoil to the surface and made extra large clods that did not completely mellow during the cropping season. This condition combined with fresh unweathered subsoil tended to reduce the yield. The most significant fact shown by the table is that the yields were good for all the cross-cultivation methods.

TABLE 7.—*Weighted yields of seed cotton per acre under different methods of cross cultivation, plot series 300*

Cross cultivations (number)	Implement	Yields on seedbed preparation A[1]							Yields on seedbed preparation B[2]		
		1932	1933	1934	1935	1936	Average 1935–36	5-year average	1935	1936	Average
		Lb.	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
2	Drag harrow	1, 287	1, 115	1, 308	1, 559	1, 205	1, 382	1, 295	1, 432	964	1, 198
3	do	1, 346	1, 074	1, 340	1, 469	1, 131	1, 300	1, 272	1, 338	948	1, 143
5	do	1, 310	1, 077	1, 352	1, 493	1, 107	1, 300	1, 268	1, 283	889	1, 086
2	Rotary hoe	1, 262	1, 044	1, 282	1, 335	1, 152	1, 243	1, 215	1, 414	949	1, 181
3	do	1, 476	1, 127	1, 400	1, 575	1, 155	1, 365	1, 347	1, 403	872	1, 137
5	do	1, 548	1, 091	1, 358	1, 510	1, 046	1, 278	1, 311	1, 328	1, 003	1, 165
7	do		1, 151	1, 433	1, 549	1, 084	1, 316	[3] 1, 304	1, 355	1, 054	1, 204
2	Weeder	1, 423	1, 081	1, 338	1, 594	1, 219	1, 406	1, 331	1, 413	997	1, 405
3	do	1, 451	1, 063	1, 276	1, 484	1, 305	1, 394	1, 316	1, 328	999	1, 163
5	do	1, 394	1, 108	1, 454	1, 506	1, 236	1, 371	1, 340	1, 310	994	1, 152
7	do				1, 678	1, 247	1, 463		1, 626	1, 090	1, 358
	Blocked with cultivator		1, 000	1, 122	1, 638	1, 068	1, 353	[3] 1, 207	1, 488	990	1, 239
	None[4]	1, 274	1, 055	1, 443	1, 692	1, 221	1, 456	1, 337	1, 546	1, 058	1, 302

[1] Seedbed plowed in January. 6 to 7 inches deep and light-bedded 2 weeks before planting.
[2] Row broken 9 inches deep in January, middles broken 8 inches deep in February.
[3] Average of 4 years.
[4] The plots receiving no cross-row cultivation were chopped to stand at the same time as series 100.

APPLICATION OF RESULTS

Figure 29 shows the labor distribution in an average year when the cotton crop is handled with one-mule tillage equipment under actual field conditions. The broken line shows the actual number of hours that a sandy loam soil can be worked during an average year. The data are based upon the hours of daylight less the time lost due to holidays, rains and wet soil. The hours required to grow the average one-mule crop of 13.55 acres (as computed from census reports) are shown by the cross-hatched area and are based on actual field data *(8)*. The double-cross-hatched area indicates the extra labor required to tend the average cotton crop. This labor must be provided by the family or hired laborers. The curves indicate that a cotton crop alone does not permit good distribution of labor. Also labor requirements for food and feed crops conflict with those for the cotton crop. The experiments described herein show that seedbed preparation for cotton can be profitably performed earlier in the year than is commonly done and that methods of cotton planting can be improved, thus lowering the labor peak of early spring. There then remains the problem of caring for the high labor demand for cultivating the young cotton.

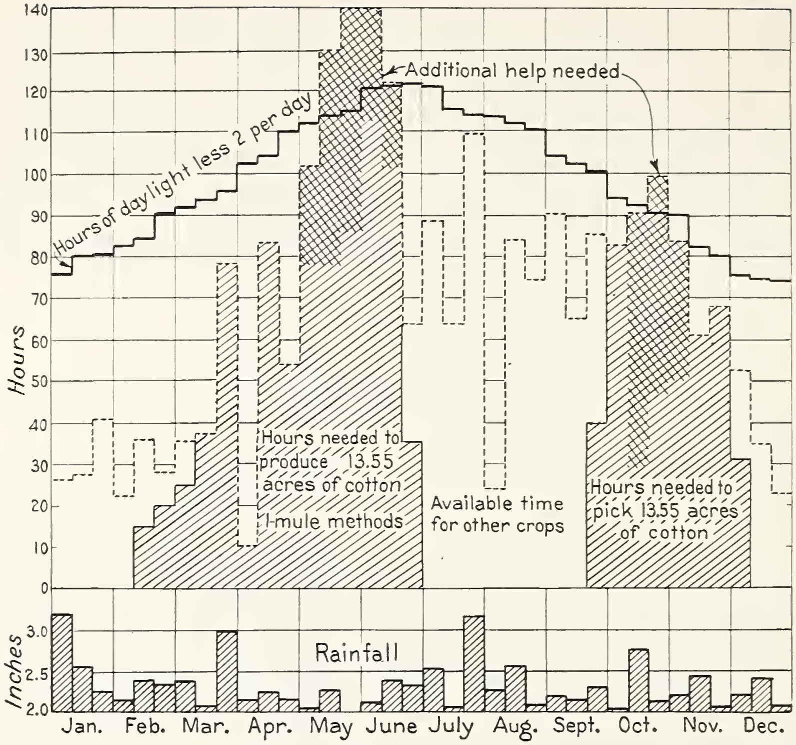

FIGURE 29.—Hours of labor required to produce a crop of cotton in an average year with rainfall as indicated.

A study of the rainfall data for the 5 years of this study shows that the soil was dry enough to work 22 days during May.

Table 8 shows the number of hours it would take one-mule and two-mule units to handle an acre of cotton by the methods shown. Thus it is evident that the acreage a one-mule farmer can cover during May varies with the method of cultivation. Since it has been shown that cultivation is required only to keep down weeds, a boy using one mule and a 7-foot springtooth weeder several times during the May labor shortage can cover more ground and obtain better yields than can be obtained with the conventional row cultivation. Hence the following procedure is recommended to reduce the May labor peak: (1) Start the cross-row cultivation as soon after planting as weeds appear or crust forms and repeat as often as necessary; (2) start chopping as soon as a good safe stand is assured and continue as fast as possible with the available labor. The cross-row cultivation should not as a rule extend into the portion of the field already chopped. However, if the implement used does not destroy any of the cotton left for stand, the entire crop may be cross-cultivated; (3) when the cross cultivation is finished, the labor and power released should be used for row cultivation. Only such hoe labor and shallow row cultivation as are needed to kill weeds should be performed after chopping; (4) finish cultivation with the number of shallow row cultivations necessary to control weeds.

TABLE 8.—*Calculated machine hours per acre required during May for various cultivation methods*

Plot No. or method	Cultivations required in May	Time required per acre	
		1-mule unit	2-mule unit
	Number	*Hours*	*Hours*
101	3	[1] 16.8	4.4
102	6	32.4	8.8
103	1	6.4	1.6
Cross cultivations:			
Drag harrow	3	5.6	2.8
Rotary hoe	3	(2)	3.0
Weeder	3	[3] 2.4	1.5

[1] 1-mule equipment requires 4 furrows on the first cultivation and 3 furrows on each additional cultivation to accomplish the work done with 2-mule equipment.

[2] All rotary hoes require 2 mules or more.

[3] A 7½-foot weeder is used with 1 mule and a 12-foot weeder with 2 mules.

During a normal season, substituting cross-row cultivations for early row cultivations should release power and labor for handling other necessary farm work. On a farm equipped with modern machine units, that is with tractor and mule power, the above plan permits the farmer to use the mules for the cross-row cultivation and releases the tractor for other work.

SUMMARY OF CULTIVATION STUDIES

The data from this field show that for these conditions cultivations should be shallow, and should occur only often enough to control weeds. Three shallow cultivations controlled the weeds at Prattville field and produced a higher yield than a larger number. All deep and miscellaneous methods of row cultivation required more power and gave lower yields than shallow cultivation with sweeps.

Cross-row cultivation with drag harrow, spring-tooth weeder, or rotary hoe controlled the weeds, removed weak plants and lengthened the chopping period. Lengthening the chopping period permits an efficient use of labor and since plants are more developed, allows hoe hands to select the better plants to leave for stand. Cross-row cultivation can be done economically as the equipment used handles a relatively wide strip and has light draft. It may be destructive to cotton planted on very loose beds or in a furrow. The operator must use judgment in the handling of equipment.

The drag harrow, weeder, and rotary hoe were found to be very effective for breaking soil crusts to allow cotton seedlings to come up. The rotary hoe seemed most satisfactory for the job.

A combination of cross-row cultivation before and during chopping time followed by enough shallow-row cultivations to keep down the weeds produced the maximum yield of seed cotton and was efficient in the use of labor.

APPARENT SPECIFIC GRAVITY STUDIES

It has been stated in the discussion of seedbed preparation that the primary purpose of tillage in cotton production is to control weeds and produce soil physical conditions most favorable for growth. Since a tremendous number of combinations of tillage operations producing almost as many soil-structure arrangements is possible, it is desirable to evaluate the methods used in terms of the effects produced in and on the soil and to evaluate these effects to cotton production. Several measures of the soil condition were tried at the Prattville field during this study. A review of the data obtained shows that the apparent specific gravity determination seems to give most consistent results. The apparent specific gravity for the conditions encountered varied from about 0.7 in the surface layer following certain machine operations to about 2.0 for some areas in plots at harvesting time.

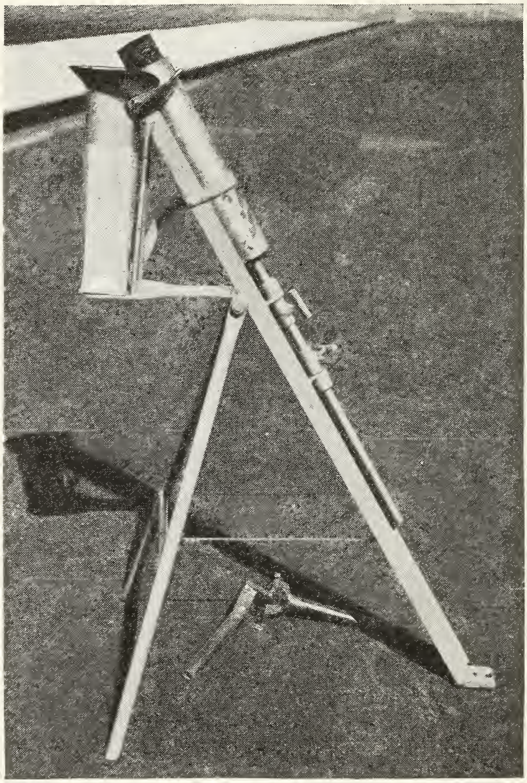

FIGURE 30.—Specific gravity apparatus.

APPARATUS

The samples for the apparent specific gravity measurements were taken with a thin-walled steel tube developed in cooperation with R. E. Yoder of the Alabama station and similar to the one used by Culpin (*3*) in a study of soil structures as they are affected by tillage.

The tube had a nominal bore of 2¾ inches tapered at the cutting edge to about 2⅝ inches. It was driven into the soil somewhat deeper than the length of sample required and was removed with the soil core. The tube is clamped to a framework, shown in figure 30, which held it in a nearly vertical position. The soil core was then pushed out of the top of the tube by a plunger moved in measured increments established by a gage and two adjustable stops. The soil section was cut off with a sharpened blade and placed in a container for drying and weighing. The weight per unit of volume was then computed, from which the apparent specific gravity was determined. To minimize the effect of the soil factors such as texture and organic-matter content, and soil variability, four to six replicate samples in 2-inch sections were taken on each plot and averaged with the replicate sections taken on the duplicate plot.

RELATIONSHIP BETWEEN APPARENT SPECIFIC GRAVITY AND YIELD

Figure 31 and data in tables 9 and 10, based on soil measurements

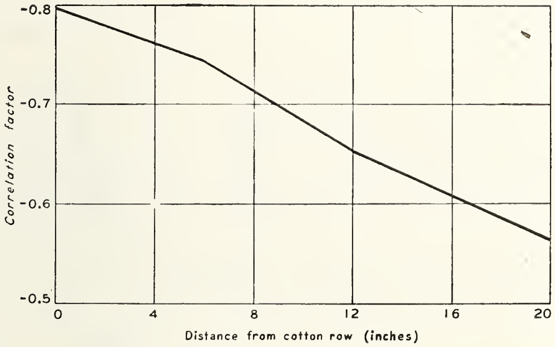

Figure 31.—Effect on yield of compaction of soil on row and at various distances from row.

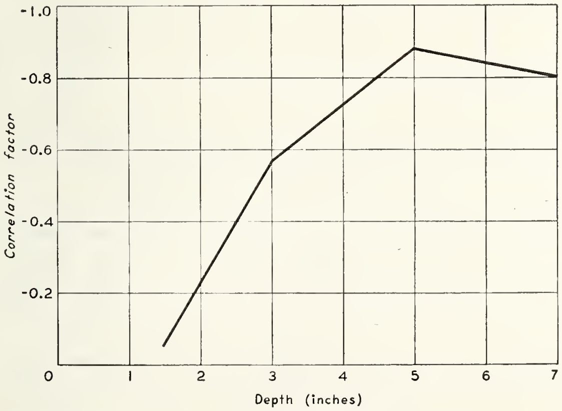

Figure 32.—Effect on yield of compactness of soil at various depths.

from selected seedbed-preparation plots, show that there is a relatively high correlation between the compaction of the soil in the cotton row and the yield of seed cotton, the higher apparent specific gravities being associated with low yields. The correlation becomes less as the distance from the row is increased, indicating that the condition of the soil between the rows is of less significance.

Figure 32 and tables 11 and 12 show the relative effects of the compactness at various depths. The condition of the top 2 inches shows no correlation with yield as this layer of soil is kept loose by the summer cultivations and was found to be in about the same physical condition for all plots. This was not the case in the area that might be considered the root zone. The correlation was significant in the 2- to 4-inch zone, was very high in the 4- to 6-inch zone, and only slightly less significant in the 6- to 8-inch zone. This relationship holds for plots prepared shallow as well as deep though these deeper layers had not been reached in the tillage operations.

Table 9.—*Apparent specific gravity of soil in row and yields of seed cotton*

Plot No.	Apparent specific gravity at indicated depth of sampling				Yield of cotton	Plot No.	Apparent specific gravity at indicated depth of sampling				Yield of cotton
	0–2 inches	2–4 inches	4–6 inches	6–8 inches			0–2 inches	2–4 inches	4–6 inches	6–8 inches	
					Pounds						*Pounds*
513	1.221	1.442	1.648	1.647	1,131	610	1.232	1.552	1.736	1.728	1,054
515	1.182	1.459	1.754	1.781	937	615	1.208	1.522	1.780	1.760	880
608	1.321	1.466	1.541	1.750	1,094	603	1.340	1.397	1.457	1.492	1,287
601	1.326	1.534	1.604	1.624	1,235	508	1.237	1.433	1.487	1.488	1,287
609	1.283	1.506	1.558	1.616	1,184	509	1.223	1.398	1.480	1.570	1,347
604	1.264	1.545	1.727	1.767	1,114	512	1.222	1.488	1.602	1.631	1,104
602	1.326	1.536	1.678	1.709	1,101	502	1.210	1.432	1.400	1.457	1,332
605	1.217	1.569	1.791	1.760	1,038	501	1.268	1.428	1.460	1.461	1,275
607	1.312	1.515	1.625	1.817	1,167	507	1.184	1.383	1.502	1.614	1,358

Table 10.—*Correlation between apparent specific gravity of soil at various depths in the row and yield of cotton* [1]

Depth	Standard error in yield of seed cotton per acre	Correlation factor	Pairs of observations
	Pounds		*Number*
0–2 inches	±131	0.209	18
2–4 inches	±102	−.653	18
4–6 inches	±62	−.886	18
6–8 inches	±84	−.778	18

[1] The apparent specific gravity on each plot is an average of at least 4 samples taken to an 8-inch depth.

Table 11.—*Average apparent specific gravity of soil between rows to a depth of 8 inches and yields of seed cotton*

Plot No.	Apparent specific gravity of soil—				Yield of cotton	Plot No.	Apparent specific gravity of soil—				Yield of cotton
	On row	6 inches from row	12 inches from row	In row middle			On row	6 inches from row	12 inches from row	In row middle	
					Pounds						*Pounds*
513	1.490	1.571	1.567	1.574	1,131	610	1.562	1.648	1.607	1.652	1,054
515	1.544	1.618	1.658	1.684	937	615	1.568	1.597	1.674	1.691	880
608	1.520	1.530	1.624	1.636	1,094	603	1.422	1.447	1.609	1.616	1,287
601	1.522	1.558	1.622	1.694	1,235	508	1.411	1.453	1.548	1.495	1,287
609	1.491	1.555	1.593	1.578	1,184	509	1.418	1.496	1.502	1.564	1,347
604	1.576	1.602	1.619	1.577	1,114	512	1.486	1.505	1.524	1.580	1,104
602	1.562	1.552	1.654	1.629	1,101	502	1.375	1.434	1.564	1.574	1,332
605	1.584	1.574	1.662	1.644	1,038	501	1.404	1.405	1.501	1.578	1,275
607	1.567	1.569	1.665	1.663	1,167	507	1.421	1.447	1.547	1.518	1,358

Table 12.—*Correlation between apparent specific gravity of soil and yield of cotton* [1]

Distance from cotton row (inches)	Standard error in yield of seed cotton per acre	Correlation factor	Pairs of observations
	Pounds		*Number*
0	±76	−0.822	18
6	±81	−.796	18
12	±97	−.695	18
20 (row middle)	±103	−.640	18

[1] The apparent specific gravity of each plot is an average of at least 4 samples taken to an 8-inch depth.

The effect of certain tillage operations in compacting the soil are shown in figure 33. These diagrams were made by plotting the apparent specific gravity readings obtained from the 1937 data and locating the points having equal density. The lines connecting these points are termed isodensity lines. The diagram for plot 401 (fig. 33) shows the condition for a plot receiving no mechanical tillage. Note that the apparent specific gravity is relatively high near the surface. The 5-year average yield was 959 pounds of seed cotton per acre. The diagram for plot 615 (fig. 33), which received 11 seedbed-preparation operations between February 1 and April 10, indicates that the soil had been highly compacted near the surface by this excessive working. This undesirable condition is due to the fact that 10 of the 11 operations were disking.

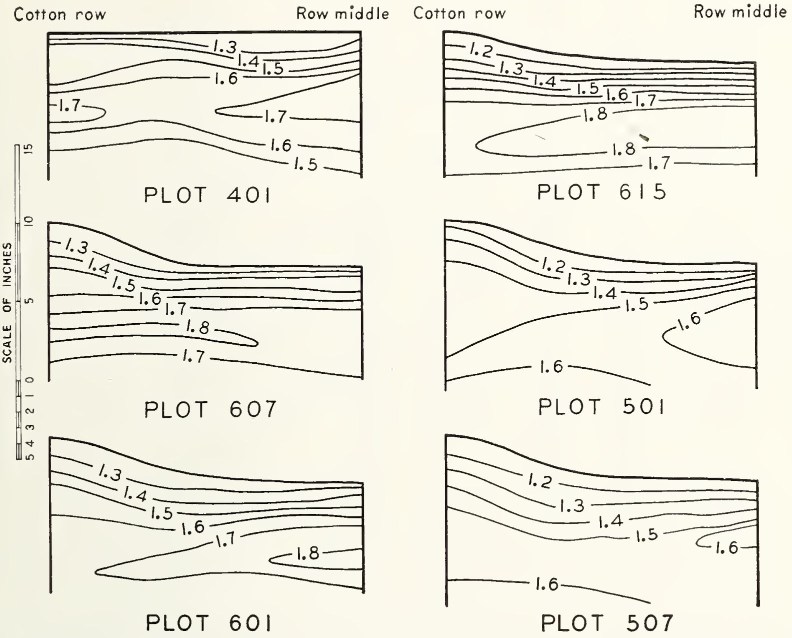

Figure 33.—Diagrams showing compaction of soils by various tillage methods. Figures represent apparent specific gravity.

The diagrams for plots 607 and 507 (fig. 33) show the relative compactness of the beds prepared in the winter by breaking out the rows, then plowing back the edges of the breaker furrows, and finally breaking out the old row middles. The diagrams for plots 501 and 601 indicate the effect of deep and shallow seedbed preparation. In plot 501 the soil structure is apparently very loose to a depth even below 8 inches while on plot 601 the dense soil below the 4-inch depth in the row would offer considerable resistance to root development. Note the comparatively sharp demarcation at which the isodensity line 1.6 comes in diagrams for plots 401, 601, 607, and 507. In each case it appears very close to the depth at which the soil is worked.

Figure 34 shows the relationship of apparent specific gravity of the soil to yield. The data for this figure are shown in table 13. The yields shown are the actual plot yields for each year and the apparent specific gravity determinations were made from samples taken on the cotton row. The 1936 apparent specific gravity data are an average of the top 6 inches of soil while that for 1937 are an average of the top 8 inches of soil. The data show that yield is definitely related to the apparent specific gravity. The data for the 1937 season give better correlation factors than the 1936 data due to the fact that the samples were taken 8 inches deep and also that one to two additional samples per plot were taken. The apparent specific gravity determinations from samples taken soon after planting show a higher correlation to yield than those made from samples taken in the fall for both seasons. The correlation factors for 1937 are −0.834 for samples taken after planting and −0.724 for the samples taken after harvest. For the season of 1936 the correlations factors are −0.699 and −0.515, respectively. This is an indication that the data are highly significant, and furthermore that the degree of compactness of the seedbed after the seed has been planted has a very striking effect on the yield of seed cotton.

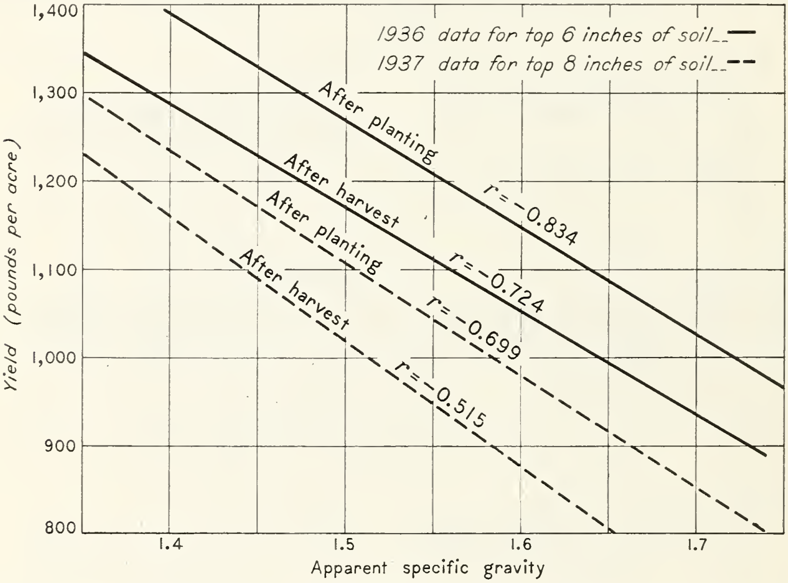

FIGURE 34.—Relationship between yield of cotton and apparent specific gravity, 1936 and 1937.

TABLE 13.—*Yield of seed cotton as related to average apparent specific gravity determinations after planting and after harvest*

[1936 data, average of top 6 inches of soil; 1937 data, average of top 8 inches of soil]

Plot No.	Apparent specific gravity				Yield of cotton per acre	
	After planting		After harvest			
	1936	1937	1936	1937	1936	1937
					Pounds	*Pounds*
501	1.376	1.479	1.388	1.405	1,299	1,311
502	1.448	1.445	1.474	1.375	1,341	1,332
503	1.465	1.584	1.403	1.497	1,385	1,374
504	1.416	1.495	1.416	1.350	1,149	1,258
505	1.407	1.461	1.424	1.366	1,199	1,277
506	1.379	1.475	1.395	1.401	1,286	1,376
507	1.371	1.393	1.421	1.399	1,145	1,377
508	1.438	1.451	1.412	1.411	1,129	1,287
509	1.492	1.461	1.388	1.418	1,199	1,347
510	1.418	1.419	1.512	1.431	1,019	1,361
511	1.403	1.495	1.539	1.431	1,320	1,248
512	1.538	1.495	1.447	1.486	899	1,104
513	--------	1.660	1.473	1.490	819	1,131
514	1.410	1.545	1.391	1.585	1,247	1,238
515	1.620	1.695	1.468	1.544	826	937
516	1.375	1.526	1.401	1.424	1,243	1,264
517 [1]	1.458	1.486	1.536	1.455	1,059	1,195
518 [1]	--------	1.680	1.563	1.566	910	1,121
519 [1]	--------	--------	1.386	1.426	1,044	1,246
525	1.324	--------	1.325	--------	1,194	--------
526	1.499	--------	1.394	--------	1,301	--------
605	1.616	1.706	1.493	1.584	953	1,038
606	1.542	1.608	1.480	1.522	1,205	1,235
607	1.531	1.599	1.561	1.567	887	1,167
608	1.558	1.651	1.477	1.520	1,100	1,094
609	1.565	1.565	1.535	1.491	1,079	1,184
610	--------	1.706	1.484	1.562	864	1,054
611	1.526	1.654	1.407	1.468	1,245	1,221
612	1.518	1.623	1.412	1.570	882	1,112
613	1.575	1.515	1.425	1.388	903	1,193
614	1.578	1.666	1.488	1.638	1,059	1,009
615	1.658	1.714	1.581	1.568	791	880
616	1.467	1.595	1.464	1.486	1,171	1,182
617 [1]	1.696	1.688	1.588	1.574	815	1,004
618 [1]	--------	1.677	1.547	1.657	628	901
619 [1]	1.599	--------	1.325	1.536	997	1,111
625	1.564	--------	1.477	--------	1,193	--------
626	1.431	--------	1.403	--------	1,277	--------

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[1] Since the data for these plots are not complete they were not included in the foregoing discussion of tillage.

Figure 34 shows also that the soil has a tendency to loosen up between the time the cotton is planted and harvest. The spread between the two lines for each season shows a reduction of roughly 0.07 in apparent specific gravity. This loosening up of the soil between the time the cotton is planted and after harvest is due in part to the root development in the soil and to the alternate drying and wetting during the growth period. The swelling of soil under a controlled set of conditions was measured on selected plots at the Prattville field. Small plots in which the soil particles were graded by sieve analysis and with no vegetative growth on them were found to increase 3 percent in volume during the growing season.

SUMMARY OF SPECIFIC GRAVITY STUDIES

Apparent specific gravity determinations of the soil in the row at Prattville field showed that the type, number, and time of the seedbed-preparation operations substantially altered the compactness at certain depths.

The data for this field indicates close correlation between yield and apparent specific gravity for certain ranges of depth in the row area. The correlation factor is especially high for the range between 4 and 8 inches deep, but there is practically no correlation shown for the condition measured in the top 2 inches. This is due to manipulation of this area by cultivation.

The average apparent specific gravity of the soil in the cotton row is less after harvest than it is in the period immediately following planting. This loosening is due in part to the permeation by roots and in part to the alternate wetting and drying of the soil through the growing season.

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